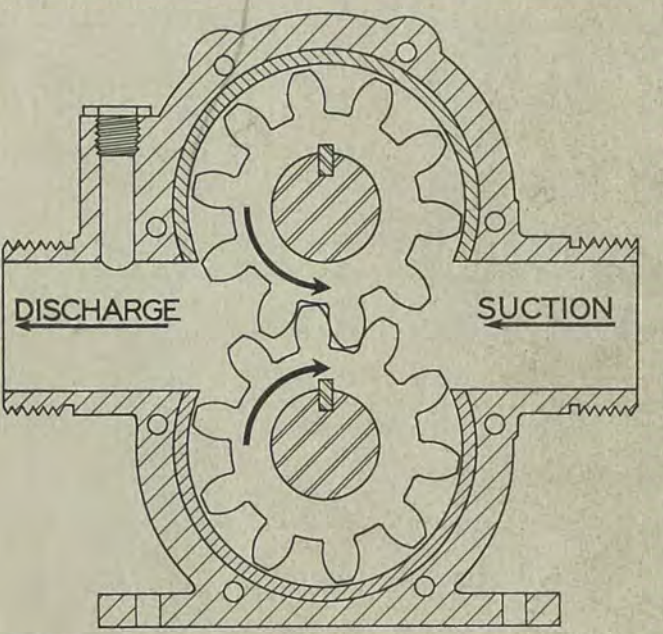
SD11
.R5

INSTRUCTORS GUIDE
FOR STANDARD TYPES OF
WATER PUMPS
USED BY U.S. FOREST SERVICE



TYPICAL GEAR PUMP

1954
FOREST SERVICE
CALIFORNIA REGION
U.S. DEPARTMENT OF AGRICULTURE

12- SERVICE MA

TABLE OF CONTENTS

	Page	Figure
INTRODUCTION	1	
AIR PRESSURE AND PUMPS	2-4	
Section 1 Air Pressure and Pumps	2,3	
Diagram Air Pressure		1
Section 2 Principles of Pumping	4	
PISTON TYPE PUMPS	5-6	
Section 3	5,6	
Diagram Piston Pumps		2
GEAR PUMPS	7-9	
Section 4 Rotary Type Pumps	7,8	
Diagram Typical Gear Pump (Side View)		3
Diagram Typical Gear Pump (End View)		4
Viking Pumps	8,9	
Diagram Viking Gear Pump		5
CENTRIFUGAL PUMPS	10-14	
Section 5 Centrifugal Pumps	10-13	
Diagram Byron Jackson 2-Stage Centrifugal		6
Diagram Closed Type Impeller for Centrifugal Pumps		7
Berkeley Pumps	13,14	
Diagram Berkeley 4-Stage Pump		8
VALVES & INSTRUMENTS	15-16	
Section 6 Valves	15	
Instruments	16	
THE PIPING SYSTEM	17,18	
Section 7		
Diagrams Piping System (Simple - Partial)		9
(Simple - Partial)		10
(Simple - complete)		11
(Gear)		12
(Centrifugal)		13
WATER EJECTORS	19-22	
Section 8 Water Ejectors	19,20,21,22	
EXHAUST PRIMERS	23	
Section 9 Exhaust Primers	23	
APPENDIX	A-1 - A-25	

- INTRODUCTION -

The purpose of this series of drawings and accompanying outlines is to aid the various people who are called upon from time to time to give instruction in pumps and fire tanker operation.

These drawings and outlines cover the various component parts that make up the pumping units in our fire fighting equipment.

Much more can be said than has been covered in these brief outlines but it will be up to the individual giving the instruction as to how much he wants to put into his instruction, or how much time he and the trainees are given to do the job.

The drawings and outline material have been compiled in such a manner that any or all may be used as group coverage, or for instruction of a single type unit.

These drawings of pumps are not exact scale reproductions, for to make it possible to trace the path of the water, certain changes were necessary. However, the general plans are correct.

Note that in the coloring of the plates: the "blue" areas represent water passages, and the areas in "orange" represent the bronze parts of the pump such as impellers and gears.

As new type pumps come into use in the Forest Service, new drawings and descriptive data will be sent to you.

Section 1

AIR PRESSURE AND PUMPS

First, it would be well to discuss briefly what physical laws of nature make it possible for pumps to operate.

Let us start by reminding ourselves that we live in an atmosphere that not only surrounds us on all sides, but also is constantly exerting pressure against us from all sides and upon the surface of the earth be it land or water.

This pressure at sea level under standard conditions is 14.7 P.S.I. (pounds per square inch). The pressure is due to the fact that air has weight as do all other forms of matter, but let us bear in mind that air is gaseous and therefore its weight by volume will vary proportionally to its density. This is why we measure air pressure under what is known as standard conditions, which are sea level at a temperature of 59 degrees Fahrenheit. Under these conditions, the weight of air is 14.7 P.S.I. (pounds per square inch).

While discussing the weight of air, let us assume we are in the mountains at an elevation of 5,000 feet. Here we find the air pressure (or weight of air) to be about 12.2 P.S.I., or at an elevation of 10,000 feet we find it to be about 9.7 P.S.I. This loss of weight is due to the fact that as we rise above sea level, we get higher into the atmosphere, which decreases the amount of air above us, and since air has weight, the less there is, the less pressure is exerted by its weight.

If you will now turn to your drawings - "Figure 1-A" - we shall discuss briefly the Mercury Barometer and how it measures air pressure (or weight of air).

Here you will note, we have a long tube (A) sealed on one end, and open on the other. This tube has a cross-sectional area of one square inch, and stands vertically with the open end immersed in a small open top tank (T) of mercury. Note that at the top end that is sealed we have installed a vacuum pump (P).

Let us now, with the aid of this pump, remove all the air from within the sealed tube. By so doing, we have removed air in the tube, which was at the same atmospheric pressure as the pressure that still remains on the surface of our mercury in the tank, i.e. 14.7 P.S.I. This results in a zero pressure, or complete vacuum, within the tube. Since the bottom of the tube is open but immersed in the mercury, the mercury will rise in the tube until the weight of the column of mercury will be equal in weight to the weight of the air, which is exerting a pressure downward of 14.7 pounds on each square inch of exposed surface of the open tank of mercury (shown by the arrows). We find the mercury (if we do this at sea level with a temperature of 59°F.) will rise 29.92 inches above the level of the mercury in the tank. In other words, under standard conditions, a column of mercury 29.92 inches high with a cross-sectional area of 1 square inch will weigh 14.7 pounds.

If you were to now measure off in inches a scale along the tube beginning with zero at the level of the mercury in the tank you would have a mercury barometer.

Barometric readings are made in inches of mercury, thus at sea level under standard conditions, your barometer would read 29.92 inches.

As you rise in elevation above sea level, you will find the barometer will read approximately 1.2 inches less for each 1000 foot rise due to decreasing air pressure.

Now let us move on to Figure I-B. Here we have a tube of identical size and shape as in Figure I-A, the only difference being we have used water in the tank in place of mercury. Let us now with the aid of the vacuum pump, remove all the air in the tube which again will result in zero pressure within the tube. We find now that water under standard conditions will rise to a height of 33.81 feet above the level of the water in the tank. This is because of the difference in weight between a given volume of water and a given volume of mercury.

In comparison a column of mercury 29.92 inches high with a cross-sectional area of one inch weighs 14.7 pounds while a column of water with a cross-sectional area of one inch must be 33.81 feet high to weigh 14.7 pounds.

For another illustration on pressure turn to Figure I-C. We have here a tube with a cross-sectional area of five square inches. Again let us create a condition of zero pressure in the tube and again our column of water, under standard conditions, will reach a height of 33.81 feet, but this column of water weighs 73.5 pounds. In this case you have exposed an area of 5 square inches under the same condition to which you exposed 1 square inch in Figure I-B; as a result you have 14.7 P.S.I. multiplied by 5 square inches which gives 73.5 lbs. total weight of the water. This condition is true because for each square inch of area in the tube at zero pressure, there is a square of water in the tank exposed to atmospheric pressure of 14.7 P.S.I. which will force the water in the tube up until the weight of water and air pressure are in balance.

From this short discussion you have an outline from which to show the ability of atmospheric pressure to lift liquids.

Section 2

PRINCIPLES OF PUMPING

In this section we will outline how our pumps depend on atmospheric pressure for their ability to pump. Nearly all pumps used in fire fighting equipment are known as pressure type pumps. Pressure is the energy which enables the water to flow through the piping system of the pump unit and on through the hose line to distant or elevated places. It overcomes the retarding action of friction in the piping and hose lines, and it also provides the necessary velocity to discharge water from the nozzle.

Water can be supplied to a pump by common methods such as a tank or hydrant, or by what is known as suction lift (often called drafting). There is little to discuss where a pump is supplied by tank or hydrant so we shall omit that phase, and deal with the suction lift.

By creating a partial vacuum within the pump and suction hose, we find the effective pressure is considerably less than the normal atmospheric pressure acting upon the surface of the water supply in which the suction hose is immersed. The greater atmospheric pressure acting on the surface of the water will cause the water to rise in the hose eventually filling the pump in the same manner that water filled the tubes in Figures 1-B and 1-C.

Other things being equal, we know that in a laboratory where tests may be made accurately the following conditions do exist:

1. At sea level at 59°F, air pressure equals 14.7 lbs. per sq. inch.
2. A column of water 1 inch square and 1 foot high equals 0.43 lbs.
3. 1 lb. of water will fill a 1 square inch column 2.3 ft. high.
4. 14.7 P.S.I. will support a 1-square inch column of water 33.81 ft. high.

There are limits of suction lifts. In actual pumping operations we cannot get a zero pressure (complete vacuum), but only a negative pressure (any pressure below 14.7 P.S.I. is negative pressure). This condition is present because of small air leaks in pump, connections in piping, hoses, wear in pump, and other mechanical defects.

In everyday use with various type pumps we find a suction lift of 26 feet at sea level to be very good performance.

We have found that for field use in fire tanker operation, the following "Rules of Thumb" can be used by fire tanker operators to a very great advantage.

1. 1 inch of mercury (1" on your vacuum gauge) equals, or will lift water by suction lift 1 foot.
2. 1-P.S.I. on discharge from pump will force water vertically 2 feet.
3. Each 1,000 ft. above sea level will show a vacuum drop of approximately 1 inch.

These rules are conservative enough so that in most cases they will cover any loss by friction or other error.

Section 3

PISTON TYPE PUMPS

Piston type pumps are one of the oldest type pumps still found in use today. On our fire fighting equipment, we use them as priming pumps on fire tankers which have centrifugal type pressure pumps. They are used as pressure pumps on our Dobbins and Bean Slip-on Units.

Turn to Figure 2 of our drawings; here a piston pump is shown in the various stages of operation.

Piston pumps are known as positive displacement pumps because it is possible to measure a definite quantity of water or air for each complete cycle or stroke of piston travel; the amount displaced being equal to the volumetric (or cubic) displacement of the cylinder in relation to piston travel.

Look at Figure 2A -- Note location of the piston. It is at the bottom of the cylinder. Now look at Figure 2E. The piston is now almost at the top of the stroke. This distance between top and bottom of stroke can be measured, and the actual cubic area computed in cubic inch displacement; thus the pump is said to be of positive type.

Let us now go over the various parts which make up this pump:

A = Main body or cylinder barrel - (usually made of brass).

B = Piston assembly. Comprising the piston valve (V), piston leathers (L) which prevent leakage between the piston and cylinder walls, and of course the piston-body itself.

C = Piston Rod. This is used to transmit a reciprocating motion to the piston, either by manual operation, or by some mechanical means from some source of power.

D = End Cap, discharge end. This serves to complete one end of the pump, and also serves as a guide for the piston rod and the discharge orifice "C".

E = End Cap, suction end. This cap completes the lower end of the pump. It contains the valve "F" (incorrectly shown as "E" on drawing), known as the foot valve and provides a means of attaching a suction pipe or hose "G".

We shall now follow through the cycles of this pump by reference to Figure 2 A, B, C, D, & E respectively.

Let us begin with Drawing "A". Here we have a dry pump with the piston at the bottom of the stroke, from the pump we have a suction pipe "G" to the water supply. Now look at Drawing "B". The piston is now traveling on the up-stroke which by so doing is creating a negative

pressure (or a partial vacuum) in the lower section of the cylinder. You will note that the foot valve "F" is open, and water is starting to pass through the valve and on into the lower part of the cylinder.

Looking at Drawing "C", we see the piston is now at the top of cylinder or top of the stroke; also since the piston has stopped and is no longer pulling water into the cylinder, the foot valve has closed.

Look now to Drawing "D". We find the piston traveling downward on the return stroke. The foot valve is still closed but the pressure on the water built up by the downward motion of the piston has forced the piston valve to open allowing the water below the piston to pass to the portion of the cylinder above the piston. When the piston reaches the bottom of the stroke and piston travel has stopped prior to starting of a new upward stroke, both foot valve and piston will be closed again as in Drawing "A". At this point we have now finished one complete cycle of piston travel.

In the last Drawing "E", you note the upward stroke of the piston is in progress, and now water is being discharged through the discharge outlet. From this point on, it is only a matter of repeating more strokes of the piston to pump additional water.

Note: You may find some of these pumps used as priming pumps for tankers which have centrifugal type pressure pumps, in which case, the foot valves have been omitted in the pump assembly itself, but are found in the suction pipe just ahead of the priming pump in the form of a check valve.

Remember a piston pump of this type is only as efficient as the piston leathers, and valves, are in their ability not to leak. If these pumps remain dry over a period of time, the leathers on the piston will shrink, and the pump will fail. Try to keep them soaked with water, or oil, at all times. Any foreigh matter such as sand or gravel, will cause a valve to remain partially open and leak, or will score walls of the cylinder causing the piston leathers to leak.

Section 4

ROTARY TYPE PUMPS

We find many types of pumps which fall under the classification of rotary pumps, such as vane, roller, gear and several others; however we shall discuss gear types since they are the types most commonly found at present in Forest Service work.

Like piston pumps, rotary pumps are of positive displacement type. Gear type rotary pumps consist of two intermeshing close-fitting gears mounted in a close-fitting case or housing. These gears are made in many designs, such as the common spur type gear which we find in the "Edwards" pump, cloverleaf design found in our "Northernor"Pacific Marine" pumps, and the internal gear such as found in "Viking" pumps. However the operating principle of all these pumps is the same.

Let us look at the Drawing Figure 3. Here we have a typical gear type rotary pump such as the "Edwards" and the Pacific Marine."

So that you may get a better picture of these pumps, we have made the Diagram Figure 3 a longitudinal cross-section showing the component parts while Figure 4 is an end view in cross-section through the center of the pump.

So that you may become familiar with these parts and their functions, we will go over these prior to discussing the actual pumping operation.

Figure 3, Sections A, B & C are the three main sections that together form the main pump case or housing. To these all the other parts of the pump are attached. The center section "B" also furnishes a mounting base with which to attach the pump to main frame of pumping unit. "D" & "E" are the shafts on which the pumping gears "F" and "F^1" are mounted. "D", the lower shaft, extends beyond the pump assembly furnishing a means of connecting the pump to a source of power; this end is called the drive end of the pump.

At the opposite end of these shafts we find the gears "G" and "G^1". They are called pilot (or load) gears. They are hard heat-treated gears used to transmit power from the driving shaft "D" to the driven shaft "E", thus removing any load of power transmittal from the pumping gears "F" and "F^1", thereby giving them longer life.

On either side of the center section, we find "H". These are the packing gland nuts used to tighten the packing "I" that prevents water and air leaks around the pump shafts. Note the four ball bearings, "J", mounted outward from the packing nuts. They carry the load of the pump shafts. The gears "G" and "G^1" run in oil or grease (depending on manufacturing specifications). Inwardly from the bearings we find "K". These are oil seals to prevent oil and grease from leaking from bearings. This gives you the important parts and their functions.

You may have some doubt as to why we call this a positive displacement pump, and what makes the displacement in this type pump. Look now to Figure 4.

Bear in mind that each tooth on these gears has a definite cubic displacement with itself. By the same reasoning, each space between each two teeth has a definite cubic volume. You will also note that the gears are closely fitted to each other and to the pump case in which they turn.

Picture now in your mind that we are turning these gears (the bottom gear turning clockwise and the top gear counter-clockwise). As we turn these gears you will notice the teeth on the right-hand side of pump are parting, leaving the area between the teeth vacant, thereby creating an area of negative pressure or partial vacuum. Since this is taking place opposite a point in the pump case where we have an opening, it is safe to assume that if this opening is exposed to the open air, or has a hose leading into a supply of water nearby, that atmospheric pressure is going to force air or water into the area of partial vacuum.

Now continue to turn the gears and you will find the areas between the teeth filled with water which will be carried between the teeth and the pump case until the water is on the opposite side of pump. We find that on the left-hand side of pump, the teeth are going into mesh, and that the space between the teeth, which now has water, is being occupied by a gear tooth forcing the water out. This water must have some place to go, and since there is an opening on the left side of the pump, it must be the path through which the displaced water will follow.

VIKING PUMPS

Please turn to Figure 5. This is an end view, with end cap removed. In Viking pumps, we find the use of the internal gear employed. By internal we mean one gear is mounted so as to revolve inside of the matching gear. This results in both gears turning in the same direction, rather than in opposite directions as in the case of the spur gear pumps such as used in Figures 3 and 4.

Note from Figure 5 the gear marked as the "drive gear." This gear is mounted on the shaft, which is the only shaft in this type pump. This shaft receives the driving power from whatever source of power you may be using. The drive gear drives the larger gear marked as the "driven gear." The driven gear is not mounted on a shaft, but is carried by the inner surface of the main pump case and the small crescent-shaped section of the main case marked "C".

Let us follow the pumping operation of this pump. You will see by the diagram that the pump is rotating clockwise. Note that at point "A" the tooth on the driven gear is leaving, or ceasing to mesh between the teeth of the driven gear. This, in turn, is creating the area at point "A" to be vacant, or with a partial vacuum. Going back to our same principle we discussed in operation of the other gear pumps, we can see that the air pressure is going to force water, or air, into this area of partial vacuum.

If you are wondering how water passes through the driven gear into the pump case, let us note that at point "B" in the driven gear, there are large open sections not shown in diagram between the gear teeth, which allow water to pass through the driven gear into the case.

Continuing on, you will note from the blue sections, water is trapped and is carried between the teeth of driving and the driven gear as well. The water is being carried to the discharge side of the main case where the teeth of the two gears again fall into mesh which, in turn, displaces the water from between the teeth. This causes the water to flow out through the openings in the driven gear, and on through the discharge opening of the main case.

The gear type pumps that we have discussed require very little attention to keep them in operation. A small amount of lubrication and repacking at the beginning of each season is normally sufficient. The packing gland should be just tight enough to stop excessive leaking around shafts. If too tight, it will result in the cutting of shafts and burning of the packing.

The main thing to watch in care and operation of gear type pumps is to make sure that only clean water is allowed to pass through the pump. Fine silt or sand will cause undue wear on the pump case and on the gears, which will increase their clearance to such an extent that the pump will no longer prime itself; however any gravel or any foreign matter will cause immediate damage or breakage. To prevent foreign matter from entering the pump, the intake end of the hose should always be protected by a suitable screen in good condition. In addition, the intake end should always be suspended in clear water and never allowed to rest on dirt or foreign matter. Consult your lube guide and "Pumper Operator's Minimum Allowable Working Pressures" for pumps you are to operate.

Another very important thing to remember is that since rotary pumps are positive in the displacement of the water, you cannot completely close off the discharge without overcoming your source of power. Also, if your power is great enough you will cause a mechanical failure, such as broken pump case or pump shaft. To overcome the chance of this, we usually install a pressure regulating valve (or By-Pass Valve) on the discharge side of the pump. This will relieve the pressure before we reach the danger point.

We will further discuss the use and operation of a pressure valve in the section on Valves.

Section 5

CENTRIFUGAL PUMPS

Centrifugal pumps are unlike piston or rotary pumps in that they are not positive displacement, and have no definite volume discharged by each revolution of the pump.

They operate on the law of Physics that a body rapidly revolving about its axis creates a force directed outward from its axis of rotation, and proportional to the speed it revolves. This is known as "Centrifugal Force."

As an illustration, take a bucket partly filled with water and whirl it over your head. You find that the water does not spill as long as you do it rapidly. Also, if you will punch a small hole in the bottom of the bucket and whirl it as before, you find the faster you whirl the bucket, the faster the water will be forced out of the small hole, and much faster than it will run out if the bucket were not in motion.

Now let us look at Diagram Figure 6 and go over the component parts of centrifugal pumps before taking up the pumping operation.

Figure 6 is a cross-sectional diagram of a two-stage Byron Jackson centrifugal pump.

It might be well to explain the meaning of the word "Stage" when used in connection with pumps.

A single stage pump is one which has one impeller mounted on the pump shaft and turning within the pump case. By connecting two or more single-stage centrifugal pumps in series, i.e. with discharge of one connected directly to the suction of the other, there results in what is known as a multiple-stage centrifugal pump. The volume of water pumped by each stage will be the same as the volume of the first stage, since all the following stages can receive only what water has gone through the first stage; however each stage will increase the pressure an equal amount providing all stages are identical in design. We will cover more on multiple stages as we progress on in our discussion of these pumps.

Looking at Figure 6, we see "A" which is the main case or body of the pump. In centrifugal pumps this is known as the "Volute" case. The pump shaft carriers "C" & "C^1" that are the impellers. There are many types of impellers; however most fire pumps are of the closed runner type. They are hollow discs with internal spiral webs as shown in Figure 7. Impellers "C & C^1" are identical in design and are mounted and fastened direct to the pump shaft so that they will turn at the same speed and the same direction. "G" is the packing gland, "F" the follower which compresses the packing "P". "E and E^1" are drain plugs located at the lower side of each stage of the pump. This provides a means to drain the water from the pump in freezing weather.

On the right-hand side of the pump, we find a gear box which contains a large gear "I" mounted on shaft "D" which drives gear "H", a small pinion mounted on the pump shaft. This assembly is known as the speed increaser.

This model pump is designed to operate from 3,000 RPM to 5,000 RPM (revolutions per minute). Since most of our sources of power are 3,000 RPM or below, it is necessary to have a speed increaser unit to get the required RPM.

This pump is built to stand 4,000 RPM maximum speed for continuous service, and will stand 5,000 RPM for infrequent, intermittent service. In most cases, we find our centrifugal pumps are designed for a maximum continous speed from 2,500 to 3,000 RPM so in most makes we do not use the speed increaser.

Figure 7 has an edge view "A" and a side view "B" of a typical centrifugal pump impeller. This view "A" is a half-cross section allowing you to see how the water enters and exits the impeller; the side view "B" shows the top half of the outer face of the impeller cut away allowing you to view the spiral fins "V".

The impeller revolves in the pump case as is shown in lower half of view "A". There is very little clearance between the impeller and the pump case.

The position on the impeller marked "S" is known as the "Suction Cone." It is at this point that water enters the impeller. Position "O" is the discharge orifice in the impeller. It is the long slots in the outer edge of the impeller formed by the spiral fins "V". At this point, the water leaves the impeller at "O" (which is the space between the spiral fins), and is collected in the cavity shown as "X" in view "A" & "B". This cavity in the Volute case is around the outer circumference of the impeller and it is in this area the water to be discharged from the pump is collected.

The pump illustrated is the "closed-impeller" type. There are many reasons why this type impeller is preferred over other types. The chief reasons are: (1) Less loss through slippage between the water and impeller; (2) Less sand or grit to wear against walls of pump case. Water entering through suction cone passes through this closed sided impeller, thus preventing sand or grit from cutting out the walls of the pump case, which would, in turn, leave a greater clearance between the impeller and case. Any wear on the inside of impeller which might occur would have little effect on the performance of the pump.

Let us now see how this type of pump operates.

You will recall at the beginning of this discussion on centrifugal pumps we mentioned that they do not have a positive displacement, and therefore will not prime themselves. This being the case, we must prime the pump before we can start and perform any pumping of water.

We find on our fire tankers that have centrifugal pumps, a small piston pump called the priming pump. With this we are able to draw water from our source of supply up and into our centrifugal pump, thereby expelling all the air and filling the inside of the pump and impeller entirely with water. With this accomplished,we can term the pump as primed.

Let us now start the pump and turn the impeller at the normal operating speed of the pump; in doing this, we are causing the water within the impeller to revolve along with the impeller. Since the water is heavy and is being revolved very fast, we set up the force known as centrifugal force. This will in turn force the water away from the center of the impeller at point "S" (the suction cone), and by so doing, we have created a negative pressure or partial vacuum area, at the center of the impeller hub, which is opposite the suction inlet of the pump. So by the same method as we pushed water into our positive displacement pumps, we shall push water into our centrifugal pumps by atmospheric pressure on our source of water supply.

You can see by looking at Figure 7 "A" the path the water will follow from the suction inlet in the pump case; first, through the suction cone of the impeller; second, the center of the impeller; third, the discharge orifice "O" of the impeller, and into the cavity in the pump case. At this point, it is collected and discharged from the pump. View "B" also shows a cut-away section of the case in which you may also trace the travel of the water.

Let us return to Figure 6 and follow the water of the Byron Jackson two-stage pump.

Since we have already covered the priming of the centrifugal pump, we shall start by assuming that the pump is primed and we are pumping at an average pump speed. We shall assume the pump is producing a pressure of 300 P.S.I. through a given size discharge orifice.

Starting at point of the suction inlet in the pump case, we find the water is passing into the first stage of the pump through the suction cone of the impeller at "S"; then passing through the impeller outward into the pump case at point "X". At point "X", it is collected and is carried from the first stage (follow the blue-colored path) of the pump over and around into the suction inlet and suction cone "S^1" of the second stage; then flowing outwardly into the pump case from which it is forced out through the pump discharge, following the path of heavy black dotted line from "X" of the second stage to the discharge opening of the pump.

The first pumping unit the water enters from the suction inlet of the pump housing is always known as the No. 1 stage. As the water passes on from one stage to another, they are numbered 1, 2, 3, 4, etc., the highest number being the final stage.

It was mentioned that the pump we have been discussing was producing 300 P.S.I. at the discharge of the pump. Now we will see where this pressure is developing. In tests it has been found that in multiple-stage pumps, such as the Byron Jackson "GMX" 2-stage, each stage (if of like design) will produce approximately the same amount of increase in pressure; i.e., if the first stage discharges its water at 100 P.S.I., the second stage that is receiving the water from the first stage at 100 P.S.I.,

will discharge water from the second stage at 200 P.S.I., the third stage receiving water at 200 P.S.I. will discharge water at 300 P.S.I., and so on as the stages are increased. Since the Byron Jackson is a 2-stage pump, and we assumed it was discharging water at 300 P.S.I., we know then each stage is producing 150 P.S.I. rise in pressure.

Before leaving the Byron Jackson pump, it would be well to note the position of the impellers on the shaft. Each impeller is facing in the opposite direction. This prevents excessive end thrust on the shaft bearings due to the pull at the point of suction of the impellers.

For service and lubrication on the Byron Jackson, check your lube guide, or go over it with the shop foreman in your forest.

BERKELEY PUMPS

Let us discuss the Berkeley 4-stage models "4DW & 2E24" since these are the type pumps on most of our Demountable Tankers.

Using Figure 8, we shall go over the various parts of these pumps.

"A" is the pump case or volute case. It houses the impellers and forms the water passages between the stages of the pump. This case is made in four sections so the pump may be assembled and disassembled. These sections are fastened to "E", which is the casting that carries the suction inlet, the packing gland, and provides a means for mounting the pump to the engine at the surface "K". It also provides a means of securing the sections of the volute case and the pressure shell "C". The pressure shell is the outside dome-shaped section you see when viewing the assembled pump. Note the four impellers, "C, C^1, C^2, & C^3" are all mounted to the pump shaft so that they all turn the same direction and speed.

Stage No. 1 is on the right-hand side of the drawing where you see the suction inlet of the pump that leads directly to this stage. To the right of No. 1 stage, you will find the packing gland "G", which contains the packing "P" and lantern ring "L". This is a hollow-pressed steel ring into which water is fed from pipe "K". This water cools the packing and furnishes a water seal around the pump shaft.

You will note that the pipe "K" gets its water from the No. 1 stage, and is taken from the case well below the outer circumference of the impeller. By so doing, the pressure to the packing gland is only 25% of the discharge pressure. "F" is the packing follower which compresses the packing when the packing adjusting nuts "N" are tightened.

At the opposite end, the left side of drawing, you will notice "B", which is the tail bearing of the pump shaft and carries the shaft load, At the extreme rear of the pump, "D" is a grease fitting that provides a way to lubricate the bearing "B". On pumps used in the Forest Service, this grease fitting will be found to be piped to the front of the pump housing just above the suction inlet on left side.

On top of the pressure shell is pipe "J". This is an outlet that provides a means of attaching a priming pump to the unit. Also note the pipe with Valve "V" (pipe and valve found only on units that have been rebuilt and modified since 1948), built to provide a better means of getting all air removed from No. 1 stage. It is imperative that No. 1 stage be completely primed if pump failure is to be eliminated.

Also on pumps overhauled in the past two years there will be the drains at point "O". There are four drain cocks at this point (only one can be seen in drawing). If you follow the passages, it can be seen that one pipe leads to each stage of the pump. These pipes provide a means of draining the water from each stage in the event of freezing weather.

Notice on the forward end of the pump shaft at "I" the flange to which the engine shaft is connected to the pump. This point should be watched closely during your weekly and after-fire checks to be sure that the four bolts connecting the flanges are tight.

Let us now check the flow of water through the pump.

Assuming the pump has been primed, we shall start the pump turning at normal operating speed 1800 to 2600 R.P.M. We find the water entering the pump through the suction inlet and into the suction cone "S" of the first stage. Here it passes through the impeller into the volute case around No. 1 stage where it is collected and passes (follow the blue water passage) from No. 1 stage over and around to the suction cone of No. 2 stage. By following the blue water passages, you can follow the water on through the stages to point "H". At point "H", the water is passed into the pressure shell "C" where it fills the shell, and is discharged through discharge outlet at the top of the pump.

Remembering from our previous discussion on centrifugal pumps that multiple stage centrifugal pumps (having each stage of like design) would give the same P.S.I. increase for each stage, we find that in this 4-stage Berkeley pump that if No. 1 stage is developing 100 P.S.I., No. 2 will develop 200 P.S.I.; No. 3, 300 P.S.I.; and No. 4, 400 P.S.I.

Since centrifugal pumps are not positive pumps, you will find the discharge may be closed while the pump is pumping and no damage will result. The impeller will simply turn and slip in the water within the case; however your pump will still be producing pressure. This pressure is known as static pressure (a force not in motion).

The main cause for centrifugal pump failure is an air leak. Any small amount of air leaking into the suction hose or pipes will cause pump failure; also any pump which has a small amount of air left in it after priming may cause the pump to fail after 10 to 30 minutes of pumping. Never prime a centrifugal pump while it is running as this only adds to your chances of trapping air within the impeller or pump case.

Section 6

VALVES & INSTRUMENTS

There are several types of valves found on our fire equipment; however, all valves are for one use -- "to regulate or control the flow of water." The most common are: gate, globe, check and pressure regulating valves (sometimes called by-pass valves).

Gate and globe valves are the most common and we find more of these in use than the other types. They are manually operated and can control the flow of water in either direction. Globe valves are usually installed so that when shut off, the pressure is opposite the stem side to prevent leakage around the packing gland and stem. Some manufacturers, however, recommend the reverse installation of this which causes the pressure to force the valve and valve seat to tighten together.

On the drawings of the piping systems, you will find gate or globe valves installed as your No. 1 and No. 2 valves and on your reel and overhead lines.

Check valves are automatic in their operation. They are opened and closed by the pressure of the water passing through them. They will allow the passage of water in only one direction, since if water tries to reverse its travel, the valve will automatically close checking the reverse flow.

Check valves are of several types; i.e., swinging, ball and straight valve and seat type. They are usually designed to work in one position either vertically or horizontally, although a few will operate in both positions.

You will find these installed on the discharge side of the centrifugal pumps. In this position, they prevent air from entering the pump while it is being primed, and also they prevent the return of water through the pump after the pump has stopped. Check valves will also be found in the pipe between the priming pump and the main pump.

Pressure Regulating Valves, which are often referred to as by-pass valves, actually do regulate pressure and by-pass pressure and water.

These valves are found on tankers that use positive type pumps either rotary or piston. They regulate the pressure which is discharged to the reels and the overboard lines and by-pass excess pressure and water back into the water tank. They are automatic in operation but may be adjusted to the desired pressure. Most of these valves operate with spring tension to maintain the desired pressure. By adjusting the tension of the spring, the desired pressure is obtained.

It would be well for people who give instruction to pick up some old valves of various types that are no longer serviceable and use these to

explain their operation. Your shop foreman, or warehouse man, no doubt have a few or could save some for you.

For more details on these valves, contact your shop foreman.

INSTRUMENTS

We find in general use on our pumping units three types of gauges; i.e., pressure, vacuum and tachometers.

Pressure gauges are connected to the discharge outlet of the pump, and denote the pressure the pump is producing in P.S.I.

Vacuum gauges are connected to the suction side of the pump, and are calibrated in inches usually from 0 to 31. They represent the readings found on a barometer; however in our use what we really get is the difference in air pressure between the atmosphere where the reading is taken, and the air pressure within the pump, suction pipes and hose.

Therefore, by our Rule of Thumb, if you had a reading 15 inches on the vacuum gauge while priming the pump, you would know that you could get the pump to draft 15 feet.

It might be well to remind you that in priming your pump, you may only have to lift your water 6 feet. If that is the case, do not expect more than about a 6-inch reading on your vacuum gauge, because if you are actually drawing water into a pump, the reading will be approximately 1 inch for each foot you are actually lifting the water.

The vacuum gauge is also very valuable in checking the unit for leaks in the piping, or the suction hose. By having the unit empty of water, close the suction pipe, or hose, and pump out the air with the priming pump until your vacuum gauge reads about 15 inches, and then let it stand a few minutes. If no noticeable drop shows on the vacuum reading, you can assume there are no serious air leaks, but if a drop shows, you had better find the leak because if the pump is the centrifugal type, you will have a pump failure.

The tachometer is a gauge for showing the R.P.M. (revolutions per minute) your pump is turning.

Where the pump and engine are directly connected, the tachometer is usually connected directly to the engine, but if the pump has a speed increaser as does the Byron Jackson, it is connected to the pump shaft.

By knowing the relation between the R.P.M. and P.S.I. output of the pump, you are able to check the performance of the pump.

There is no need to go into the construction of these instruments, since you people will have no occasion to repair or otherwise service these units.

Section 7

To the stranger who walks up to a fire tanker and sees for the first time the maze of pipes and valves that make up the pumping unit, it seems like a very complicated piece of equipment.

In order to make these units seem less complicated, and to give the tanker operator enough knowledge to enable him to take any fire tanker, and in a short time, trace out the pipes and valves and go ahead and operate the unit, we have prepared the piping diagrams Figure 9 through Figure 13, showing the basic piping of our fire tankers.

Starting with Figure 9, you see a very simple pumping unit, a tank for the water supply connected to a pump by a suction pipe and a short piece of discharge pipe known as the overboard discharge.

Study this well and fix it in your mind, since to this basic unit we shall add pipes and valves until we have a pump unit that will perform all the operations of a fire tanker.

In Figure 9, we are able to do but one operation, that is to pump water from the supply tank overboard, or to the reels.

Let us assume we need to pump from a stream or some other source other than the tank. Please look at Figure 10.

You find we have introduced the valve known as No. 1; also, another type that we will know as our overboard suction. Now by closing No. 1 valve, we are able to pump from the stream to our overboard discharge line. However, we find it necessary sometimes to draft from our overboard suction to fill our tank.

Turn to Figure 11. We have added a little more pipe and a valve known as No. 2; our new pipe connects the discharge of the pump to the tank. This makes it possible either to pump direct from the tank to the over-board discharge, or to the reels by opening Valve No. 1 and closing Valve No. 2. We can also close No. 1 and draft from stream to overboard discharge and the reels, or, if we wish, we may with Valve No. 1 closed and Valve No. 2 open, draft from stream and fill the tank. These are the three required basic operations of a fire tanker. However, different types of pumps make it necessary to add a few more pipes and valves in order that the unit can function properly. Please turn to Figure 12.

Figure 12 represents the piping needed to operate a unit with a positive displacement pump (Rotary or piston). We must add another piece of pipe and a pressure regulating valve (or by-pass valve). We still have our No. 1 and No. 2 valves, which operate the same as before plus the pressure regulating valve. This pressure regulating valve is essential as a safety measure to regulate our pressure and to by-pass the pressure and water should our reels or overboard line be closed while the pump is operating.

Turn to Figure 13, which is a diagram using the centrifugal pump. We still have No. 1 and No. 2 valves in their usual position and doing the same job, but have added a check valve in the discharge pipe next to the pump. The main purpose of the check valve is to close the discharge side of the pump while you are priming the pump with the hand primer, which allows the discharge opening to remain open when you start the pump.

Go back and study these diagrams and fix them in your mind, and you will soon see how simple the pump unit of your fire tanker really is.

Section 8

WATER EJECTORS

The Water Ejector is not a recently developed type pump, but it has only lately become part of our Forest Service Fire Fighting Equipment.

The U. S. Forest Service Development Center at Arcadia has spent a great deal of time testing and doing research on various types of Water Ejectors. From this work they have developed the performance data on the makes and sizes best fitted to our Fire Fighting needs.

Also the Development Center has prepared and printed a brochure, Equipment Development Report No. 20, entitled "WATER EJECTORS for FOREST FIRE FIGHTING". This is filled with valuable information and illustrations on different ways we can use Ejectors in Fire Tanker operation. The information following has been adapted from that brochure.

Since our regular Fire Pumps have a limitation of about 20 feet at sea level for suction lift, it is here the Ejector gives us an added pumping performance.

With the use of an Ejector we can, if we so desire, lift water from 80 feet or more below the Tanker pump and from a distance of 200 feet or more on the level. This is an advantage when we are unable to drive the Fire Pumper within a few feet or our source of water.

Now let us look at the drawing Fig. 14 of our charts.

You will note from the drawing the Ejector is a very simple device and has no moving parts; therefore, it requires no adjustment.

The Ejector you see in the drawing is about the size of the largest we will use in our Fire Fighting work. This means they are small and compact, making them easy to carry and store on our Fire Pumpers.

The drawing we are using as an illustration is a cross-sectional view of an Ejector, cut in half lengthwise, showing the inside shape.

Viewing this drawing, let us trace the action which takes place within the Ejector while it is in operation. You will note there are three openings into the body of the Ejector, P, B and C. P is the pressure entrance, B is the suction entrance and C the discharge outlet.

Assume now we are going to use the Ejector and would have it connected in the following manner: 1. Discharge of Tanker pump

connected by use of the hose to the pressure entrance of Ejector at P. 2. Foot valve and strainer have been connected on suction inlet B of Ejector. 3. Hose has been connected to discharge opening of Ejector at C, and returned to Pumper Tank. 4. Ejector has been submerged in our source of water. It is also necessary that we have enough water in the tank of our Tanker to fill the hose connecting the Tanker pump with the Ejector, and enough water to last until we can get water back into the Pumper tank from Ejector. The ability of the Ejector to pump depends on the water pumped into it from the Tanker pump.

The foot valve is placed on the suction to prevent the loss of the water we have in our Tanker before the pumping operation starts. It is desirable that the foot valve be of the strainer type with spring controlled valve, as this type will operate in any position.

We are now ready to place the Ejector in operation. Let us start to pump water under pressure from the Tanker into the Ejector. The water enters the Ejector at P under high pressure; here it is forced thru the nozzle A, which transforms the high pressure stream of water into a high velocity stream, which is directed into the center of the Venturi tube section of the Ejector, (this is the portion of the ejector which looks like two funnels placed back to back and terminates in opening C). As this high velocity stream is discharged from nozzle A, it picks up additional water from the compartment in the Ejector around the nozzle and the entrance of the Venturi. This is carried thru the Venturi and out of the discharge opening C. In doing this it creates a low pressure area or partial vacuum around the nozzle stream. This in turn allows the atmospheric pressure on our source of water to force water thru the foot valve and opening B, starting a flow of water thru the Ejector, and the pumping cycle is now in operation.

Now that we have learned the mechanics of how the WATER EJECTOR operates, let us discuss what it will do in various operations.

The following lists some of the advantages of the Ejector in our work.

1. No need for heavy suction hose, (uses the hose carried on the pumper).
2. Will not fail to operate even with a few leaks at hose connections.
3. No running a dry pump while trying to draft.
4. Can lift water vertically more than 80 feet.
5. Can draw water from over 200 feet on the level.
6. Makes a small pump have large pump performance in ordinary drafting operations.
7. Makes dirty water usable for fire fighting without running it thru Tanker pump. Also, at the same time increases usable water up to 3 times as in Fig. 17.

Before we continue it should be mentioned that it is difficult to set up a simple rule to guide the operator in each operation he may have

for the Ejector. Maybe his truck only has one size, Ejector leaving him no choice; also the variables of friction on different hose lays all affect the final results.

Perhaps after the operator has been given the basic knowledge of Ejectors and their use, his best training will then be to use his Pumper and practice with the Ejector or Ejectors he has to best suit his need.

It would be ideal if each Fire Pumper could have at least two Ejectors; this would take care of most pumping operations.

Turn now to the drawing Fig. 15. Here we have three conditions where EJECTORS can be used very successfully, namely:

A. High lift, using approximately full pump capacity for filling tank.
B. Low lift, using approximately full pump capacity for filling tank.
C. Using one half the pumper output to operate the EJECTOR, and keeping the tank full and the other half for Fire Suppression.

You will notice in the upper right hand corner of the drawing that there are two blocks of figures. The top block headed "CONDITION" lists the makes and models of different pumps and which EJECTOR to use with each pump under the three conditions. The lower block headed "EJECTORS" and numbered 1 thru 7 gives the make and size of the Ejector referred to in the Condition chart.

The information in the above chart is from actual tests conducted by the Arcadia Development Center. By referring to the Development Center's brochure on "WATER EJECTORS", Table 1, on the "Capacity of Ejectors," it is possible to select the Ejector to be used with any pump where the normal pump output in G.P.M. and P.S.I. is known. Also in their brochure is a table showing how much reserve water you must have in the tank to place a given Ejector with a given hose size and length in operation.

Now take any pump you choose to select, fit it to the conditions shown in the drawing and you will find by use of the figures in the upper right hand corner that a selection of two EJECTORS will cover all conditions. This means if you have two proper selected EJECTORS on your Pumper, you can perform almost any desired pumping operation.

Turn to Fig. 16. Here you see an EJECTOR on a low lift operation. Note the Tanker pump is pumping 15 GPM into the EJECTOR and the EJECTOR is returning 46 GPM. This means 15 GPM from 46 GPM or 31 GPM of water to be used in Fire Suppression.

In low lifts (below 50 feet) such as in Fig. 16, high pressures are unnecessary for EJECTOR operation. The object here is to get maximum flow to fill the tank rapidly. As a rule of thumb, one foot lift for

each three pounds per square inch of pressure, is the maximum for efficient operation. Thus, if the lift is 50 feet the pressure necessary is 150 PSI.

Turn to Fig. 17. Here you see the EJECTOR pumping dirty water and also increasing the usable water to 3 times the Pumper capacity.

It may be necessary at some time for you to use an EJECTOR when it is impossible to have it submerged. Turn to Fig. 18. This is an illustration of how an EJECTOR is used even though not submerged. Simply connect suction type hose between the Ejector and foot valve,

and place foot valve under water.

You have now covered the basic information on EJECTORS and their use. Study the appendix of this manual, and do some practical work, actually using Ejectors.

EXHAUST PRIMERS

To many of you, the use of the engine exhaust to prime centrifugal pumps may be new.

They are now in use on our new HALE MODEL - HPZZ and BERKELEY MODEL - 1½ TQ4 pumps.

The EXHAUST PRIMER employs the use of an ejector very similar to the ones we use to pump water. The chief difference is that we use the velocity of the exhaust gases to operate the ejector instead of water.

Turn to Fig. 19 and we will review the parts which make up the EXHAUST PRIMER.

The Exhaust Primer is cylindrical in shape. The drawing shows it cut in half lengthwise thru the center.

First let us look at drawing No. 1 of Fig. 19 and identify the different parts and their purpose. J is the main outside jacket to which all other parts are attached. The large inner cavity M formed by jacket J is used as the engine muffler. E is the engine exhaust entrance. The opening on the top of J is for the escape of exhaust gases under normal operation; the handle H and valve C form the exhaust valve and are used to shut off the escaping gases when the ejector D is in operation. P is the suction line connecting ejector D with the pump unit to be primed. The tube T is the pressure line to the ejector. As you can see from the drawing the ejector D is made up of a nozzle and venturi tube very much the same as the water ejector.

While engine is operating under normal pumping operation, exhaust gases enter the muffler unit thru opening E, there they are muffled and cooled, then expelled thru the open exhaust valve C.

When we wish to prime the pump we close exhaust valve C (as in drawing No. 2); this forces the exhaust gases down the tube T, and thru the nozzle of the ejector D. Here the high velocity stream of gas picks up air from within the ejector, and expels it thru the venturi; this creates a partial vacuum around the nozzle stream. This partial vacuum keeps increasing until water is drawn thru pump, expelling all air and priming pump.

We have found these Exhaust Primers very affective, producing 22 inches of vacuum at sea level.

They require very little maintenance. It will be necessary from time to time to clean and remove carbon from within the ejector unit.

APPENDIX

A P P E N D I X

TABLE OF CONTENTS

	Page
TANKER - INSPECTION AND RECORD FORMS	A - 1 - A - 3
WATER EJECTOR PERFORMANCE DATA	A - 4 - A - 15
WATER EJECTOR USE DIAGRAMS	A - 16 - A - 19
NOZZLE DISCHARGE CHART	A - 20
SUCTION LIFT OF PUMPS AT DIFFERENT ALTITUDES (Chart)	A - 21
FIRE HOSE CONVERSION CHART	A - 21
FIRE PUMP - SPECIFICATIONS & CHARACTERISTICS	A - 22 - A - 24
LOAD LIMITATION CHART FOR TRUCKS	A - 25
HOSE THREAD STANDARDS & FITTINGS	**A - 26**

Form 127-R5 Forest _____

BEFORE OPERATION DAILY CHECK FOR PUMPER TANKERS

LOCATION _____ F. S. No. _____ Date: From _____ to _____

		M	T	W	T	F	S	S
1	Is vehicle engine oil at proper level?							
2	Is water in radiator at proper level?							
3	Are all tires properly inflated?							
4	Are there any water, fuel or oil leaks?							
5	Is all equipment properly fastened in place?							
6	Is vehicle cab and all compartments clean and neat?							
7	Are tools or equipment loose in cab?							
8	Does horn operate properly?							
9	Does brake pedal have adequate reserve movement?							
10	Is vehicle gasoline tank full?							
11	Are all lights working, including high and low beam?							
12	Is oil in pumper engine at proper level?							
13	Is pumper engine gasoline tank full?							
14	Is main supply tank filled with water?							
15	Is all glass clean and in good condition?							
	Checked and deficiencies corrected by (show initials)							

REMARKS _____

Make this check daily as instructed, except when weekly inspection is required. Then use the WEEKLY OR AFTER-OPERATION MAINTENANCE CHECK SHEET FOR FIRE PUMPER TANKER form. Draw line down through daily column to indicate that weekly check was substituted.

AGRICULTURE—FOREST SERVICE—SAN FRANCISCO

WEEKLY OR AFTER-OPERATION MAINTENANCE CHECK SHEET FOR FIRE PUMPER TANKERS

This form is to be made in duplicate and will be used in lieu of AUTOMOTIVE EQUIPMENT INSPECTION REPORT (Form). Forward original copy through Supervisor to Forest Shop. The duplicate copy will be retained in equipment Log Book.

TRUCK FS No. ..... TYPE ..... MILEAGE ..... DATE ..... LOCATION .....
Use "✓" mark in blocks to indicate item is satisfactory or has been made satisfactory during this inspection.
Use "X" mark in blocks to indicate item which requires attention beyond capacity or facilities of operator.

SECTION I — VEHICLE AND ACCESSORY FIRE EQUIPMENT

1 ☐ Are entries in Equipment Log Book properly recorded?
2 ☐ Are credit cards stapled in Equipment Log Book?
3 ☐ Is unit supplied with accident forms as required?
4 ☐ Is unit supplied with other forms, if required?
5 ☐ Is unit supplied with spare bulbs and fuses? (if required)
6 ☐ Are lubrication services properly performed at regular intervals?
7 ☐ Is air cleaner properly maintained?
8 ☐ Is engine oil at proper level?
9 ☐ Is water in radiator at proper level?
10 ☐ Are all tires including spare properly inflated and in compliance with safety requirements?
11 ☐ Are safety reflectors clean and in good condition?
12 ☐ Is rear view mirror tight and clean?
13 ☐ Does signal arm operate properly? (if equipped)
14 ☐ Does starter turn engine freely?
15 ☐ Does engine start easily?
16 ☐ Are all engine controls functioning properly? This includes choke, hand throttle, switches, etc.
17 Are all dash instruments functioning?
18 ☐ Are fan belts functioning properly?
19 ☐ Does engine run smoothly under load? (Determine after engine has been warmed 15 minutes at fairly fast idle.)
20 ☐ Does vehicle handle properly in driving test?
21 ☐ Does vehicle steer properly?
22 ☐ Does clutch and gear shift function properly?
23 ☐ Are foot brakes fully effective?
24 ☐ Is hand brake fully effective for holding vehicle?
25 ☐ Are windshield wipers tight and operating properly?
26 ☐ Do siren and horn operate properly?
27 ☐ Is tie rod straight? (visual inspection)
28 ☐ Are all wheel or lug nuts tight?
29 ☐ Are cab and all compartments clean and neat?
30 ☐ Is all equipment properly fastened in place?
31 ☐ Are tools or equipment loose in cab?
32 ☐ Are all lights functioning, including high and low beam?
33 ☐ Is all cab glass clean and in good condition?
34 ☐ Is battery fastened securely, clean, and water level correctly maintained?

SECTION II — PUMPER OR PUMPER UNIT

Tanker F.S. No. ..... (Items marked with (*) apply only to DT pumpers or units with auxiliary engines.)

35 ☐ Is rock trap, suction, and tank strainer clean?
36 ☐ Does hand priming pump function properly?
37 ☐ Is suction hose in good condition?
38* ☐ Does starter turn pumper engine freely?
39* ☐ Does pumper engine start easily?
40* ☐ Are fan belts functioning properly? (if equipped)
41* ☐ Do controls of pumper engine function properly? This includes choke, hand throttle, switches, etc.
42 ☐ Are all pumper instruments functioning properly?
43 ☐ Is pump operating efficiently? (Operate at rated working pressure as per instructions.)
44 ☐ Are there any water leaks under pressure?
45 ☐ Are all valves operating properly and handles tight?
46 ☐ Is pump or pumper unit lubricated properly?
47* ☐ Is oil changed at proper intervals?
48* ☐ Is air cleaner properly maintained?
49* ☐ Is oil at proper level in pumper engine?
50 ☐ Is supply of pump lubricant with unit? (if required)
51* ☐ Is battery fastened securely, clean, and water level maintained?
52 ☐ Is main supply tank filled with water?
53 ☐ Are entries in Pumper Log Book correctly recorded?

SECTION III — GENERAL

54 ☐ Are truck and pumper gas tanks full?
55 ☐ Are wheel chocks and tow cable on truck?
56 ☐ Do fire equipment and accessories check with list?
57 ☐ Are both units free from water, fuel or oil leaks?
58 ☐ Is the provided jack in good condition and adequate?
59 ☐ Is combination of units in safe condition to operate?
60 ☐ FREEZING WEATHER ITEMS: Are the following items drained? Pump, piping, radiators, engine blocks, etc.

REMARKS _____

Submitted by _____

GPO 966211

Form 128 R-5-Rev. Feb. 1954

FC-100A

Forest_____

Date_____

SUPPLEMENT TO TANK TRUCK RECORD
PORTABLE POWER PUMPER USE

Serial No.	Make	Model or Type	How Used		*Date of Last Inspection	Total Annual Use	
			As Portable	As Tanker		No. of Fires Used On	No. of Hours of Use

EJECTOR PERFORMANCE

The following pages contain performance curves Figures 1 to 7 inclusive, for the seven EJECTORS tested.

One example is worked out to explain use of the curves. Refer to #3 EJECTOR.

Given a pumper rated at 15 gpm @ 250 psi, and a #3 EJECTOR. What output and lift is possible when the pumper is working at 200 psi? Start at (1) and follow dotted line up to (2). Eleven gpm (read on the left side of chart) is used by the EJECTOR. At this point (2), intersect the curve marked 60 psi, or 138 foot lift. So this 11 gpm can be lifted 138 feet. Since this is the amount pumped to EJECTOR, it is indicated that no water is picked up by the EJECTOR. Continuing up the 200 psi line to (3), intersect 50 psi or 115 foot lift. Reading gpm on the left side, find 16 gpm as the flow which can be lifted 115 feet. This shows 5 gpm picked up thru the suction (16-11).

Continuing up to (4), intersect curve marked 40 psi or 92 feet. The flow here is 20 gpm, indicating that 9 gallons have been picked up by the 11 gpm flow. At (5), maximum flow of 23 gpm is reached, which can be lifted somewhere between 69 feet and 92 feet, approximately 88 feet.

In this manner, it is possible to determine output and lift possible at any pressure the pumper is being operated.

FRICTION LOSS IN HOSE

Shown in feet (head) and pressure in pounds per square inch.

Gallons per Minute	3/4" Hose		1" Hose		1½" Hose		2" Hose	
	Feet	Psi	Feet	Psi	Feet	Psi	Feet	Psi
5	9	4	2	1	.3	.1	0	0
10	32	14	8	3.6	1	.4	0	0
15	69	30	17	7.4	2	.9	0	0
20	115	50	29	12.6	4	1.7	1	.4
25	173	75	43.7	19	6	2.6	1.4	.6
30			61	26.5	8.5	3.7	2	.9
35			81	35.2	11	4.8	2.7	1.2
40			115	50	14	6.1	3.5	1.5
45					18	7.9	4.3	1.9
50					22	9.6	5.2	2.3
60					30	13	7.3	3.2
70					40	17.4	9.8	4.3
80					52	22.6	12.6	5.5
90					64	27.8	15.7	6.7
100					77	33.5	18.9	8.2
125					121	52.6	28.6	12.4

Note:- In the above table, psi multiplied by 2.3 gives feet (head).

#1 EJECTOR

Test Dates:

June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

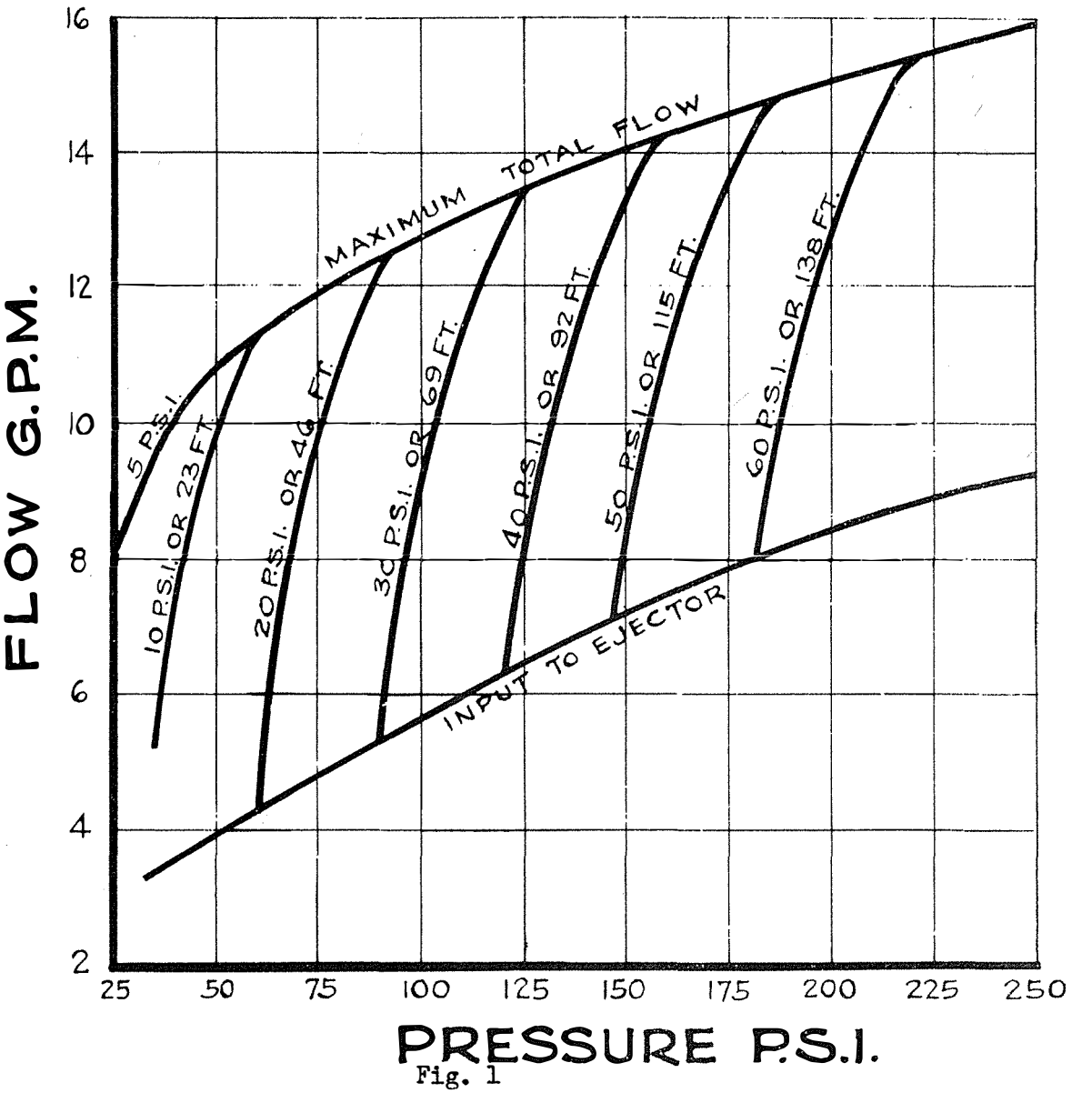


Fig. 1

2 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

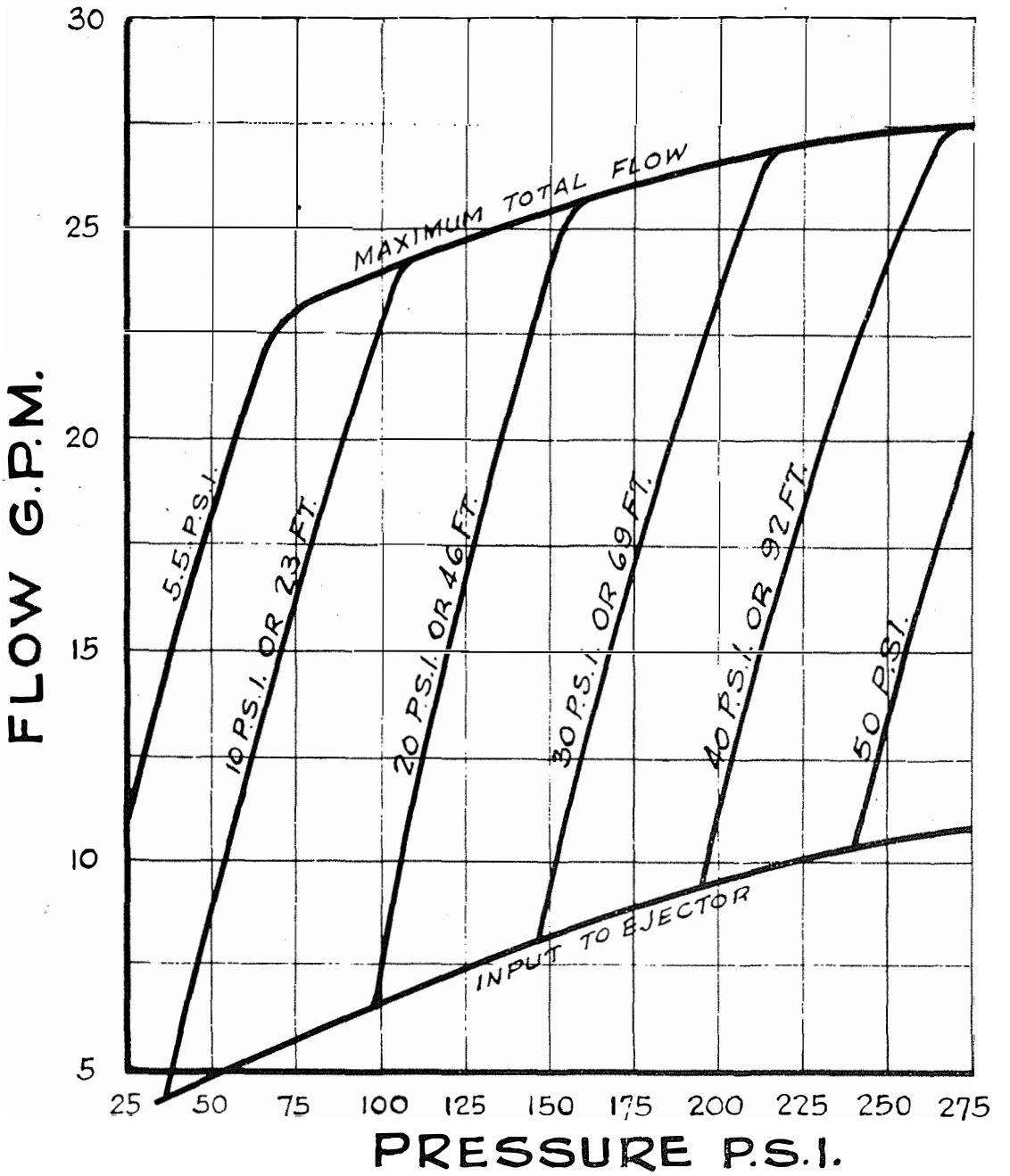


Fig. 2

#3 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

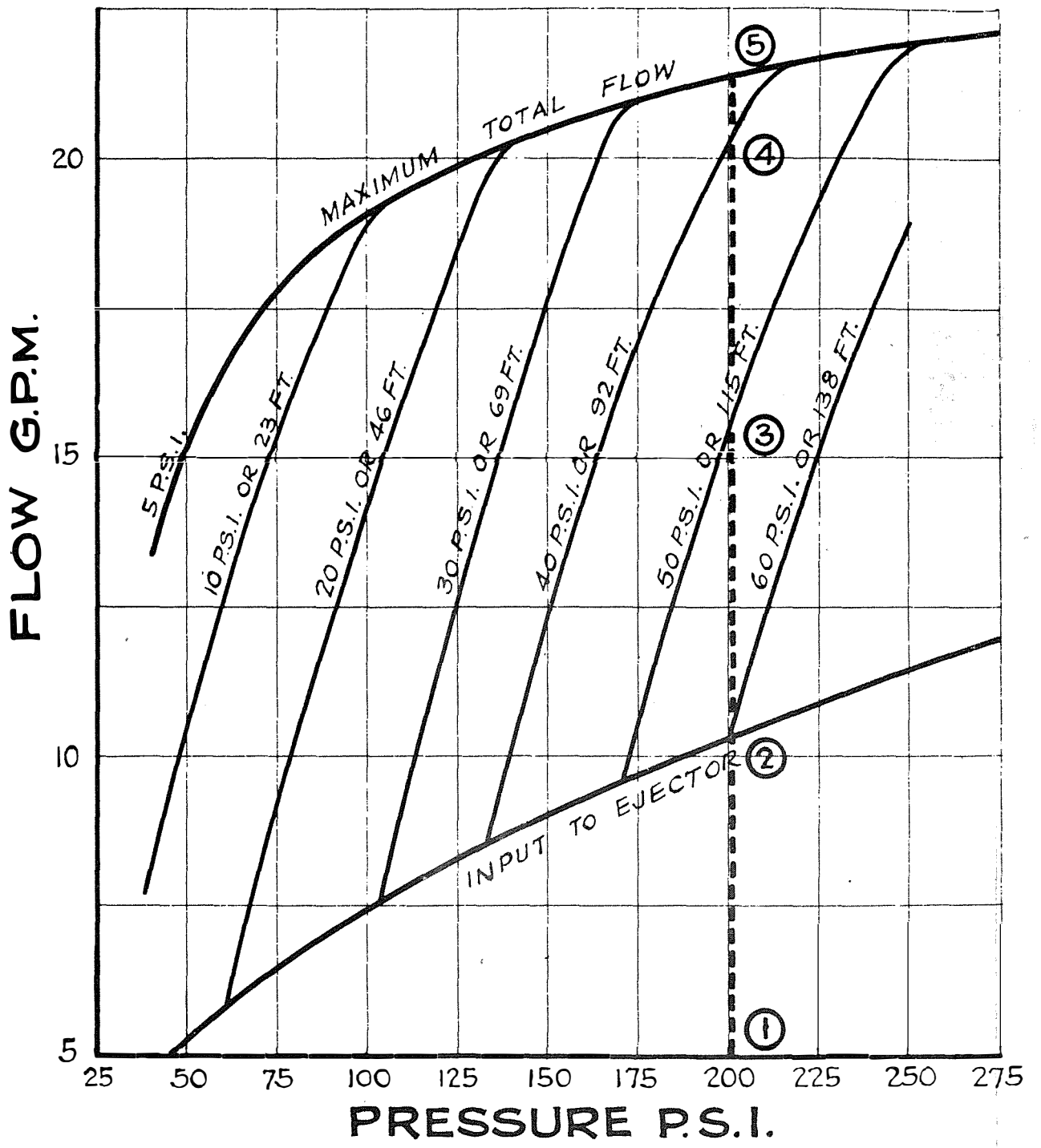


Fig. 3

#4 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

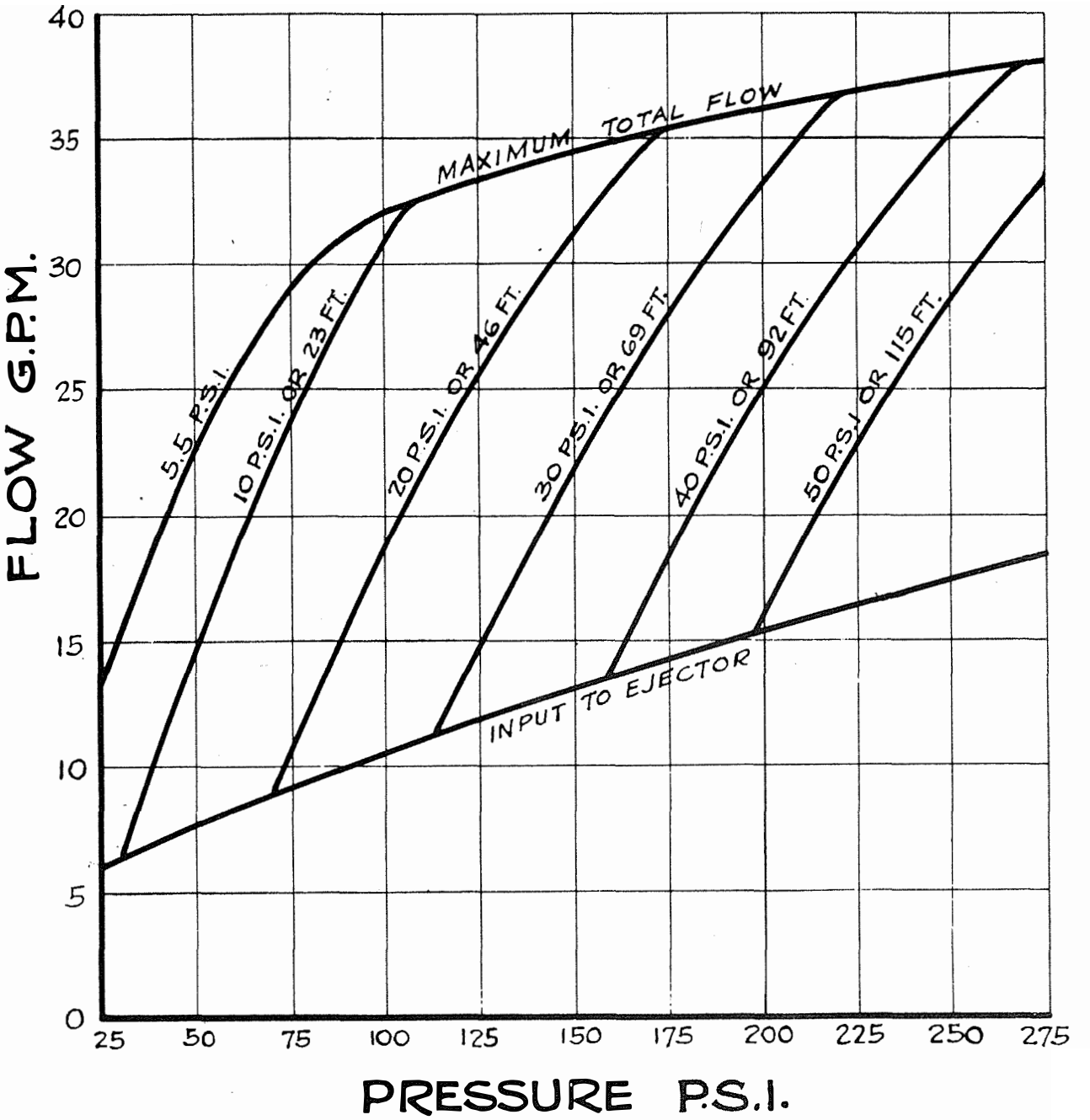


Fig. 4

#5 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

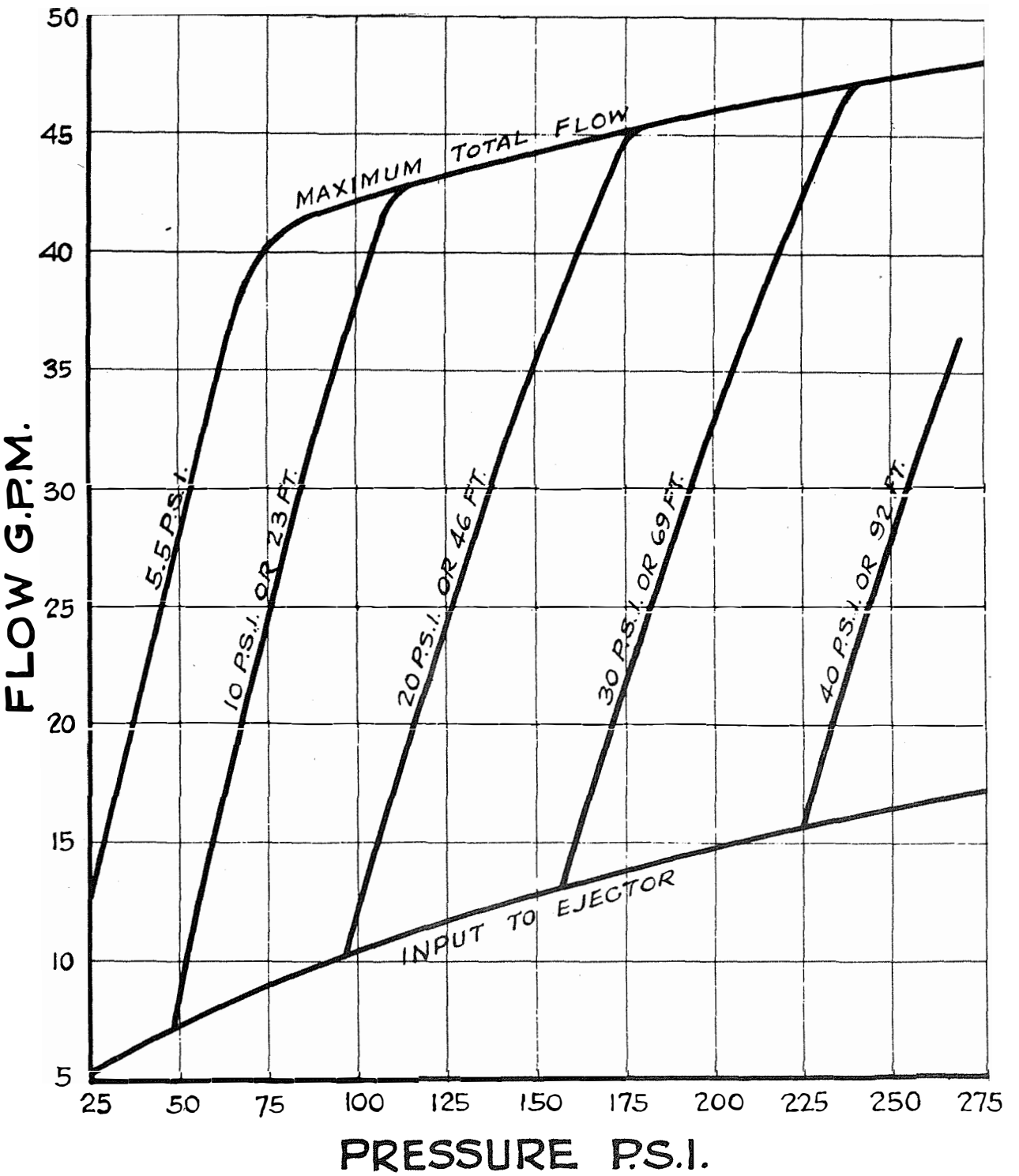


Fig. 5

#6 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

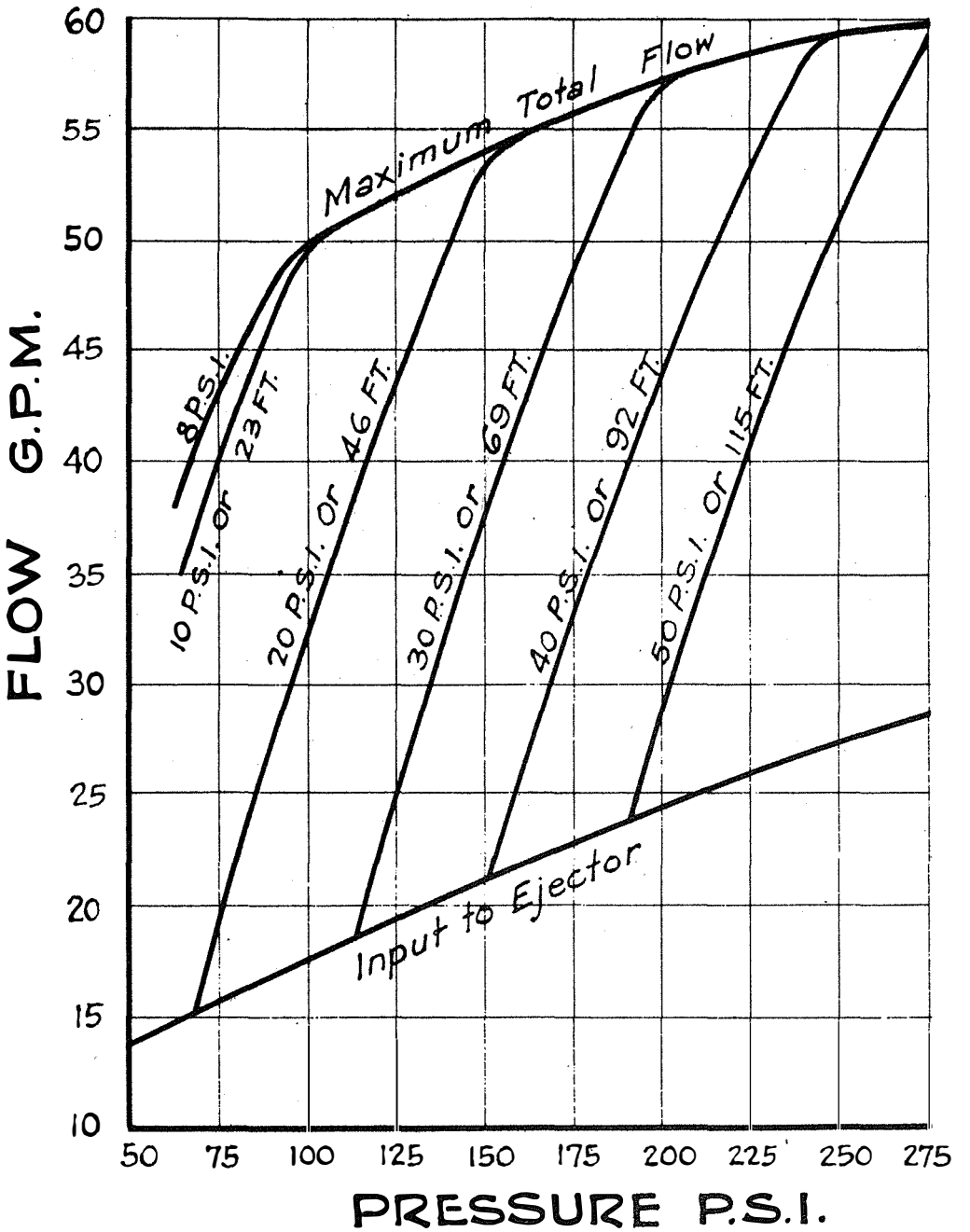


Fig. 6

7 EJECTOR

Test Dates:
June & July 1950
May & June 1951

EJECTOR PERFORMANCE CURVES

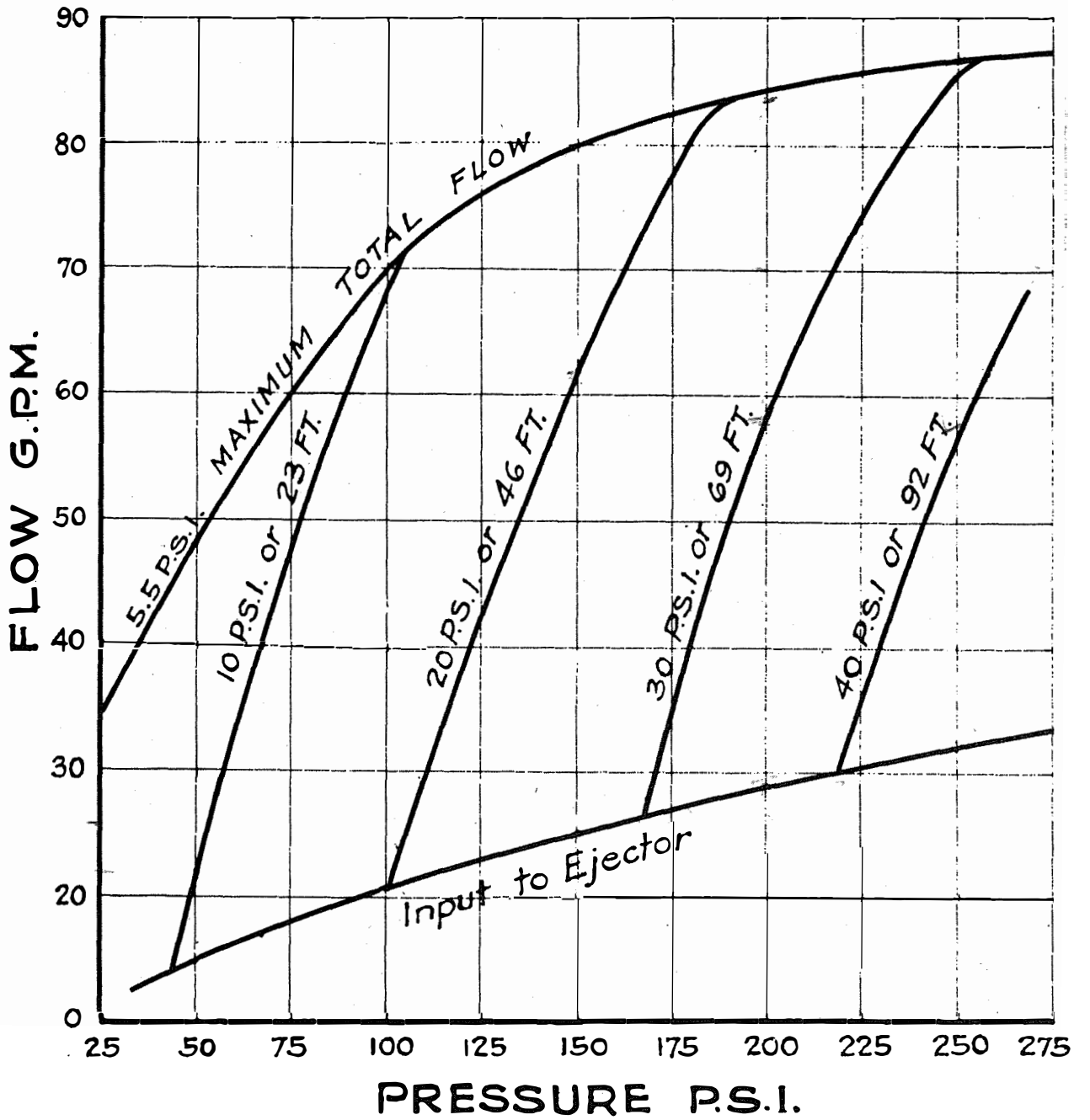


Fig. 7

PURCHASING EJECTORS

There are many manufacturers of EJECTORS. While those tested at Arcadia included Penberthy, Berkeley and Pacific Pump, they, by no means, cover the field.

In general, EJECTORS can be purchased through any large hardware outlet or plumbing supply source.

All manufacturers have performance curves for their EJECTORS and selection can be made so as to obtain performance comparable to those listed in this report.

MARKING EJECTORS FOR IDENTIFICATION

Each EJECTOR purchased should be stamped to facilitate identification in the field. EJECTORS which have been sent out by the Arcadia Equipment Development Center have the capacity at 250 psi pressure stamped in the intake end as follows:

Ejector No. 1 - 9	Ejector No. 4 - 17
No. 2 - 10	No. 5 - 16
No. 3 - 11	No. 6 - 27
	No. 7 - 32

CAUTION: Be careful when stamping EJECTORS. Stamp only on the thicker portions.

FITTINGS NECESSARY TO HOOK UP EJECTORS

The following table shows pipe connections necessary for each EJECTOR:

PENBERTHY EJECTORS

	Swivel Connection Female NPSH To Male NPT	Bell Reducer NPT	Bushing (Brass Preferred) NPT
No. 62 A	1"	1" to 3/8"	(Two) 3/4" to 1½"
No. 63 A	1"	1" to 1/2"	(Two) 1" to 1½"
No. 64 A	1"	1" to 3/4"	(Two) 1¼" to 1½"

BERKELEY EJECTORS

	Swivel Connection Female NPSH To Male NPT	45° L NPT	Nipple 2½" long NPT	Bushing NPT
00-9-18	1" to 3/4"	3/4"	1"	1" to 1½" (Two)
0-10-28	1" to 1"	1"	1"	1¼" to 1½" 1" to 1½"
0-12-38	1" to 1"	1"	1"	1¼" to 1½" 1" to 1½"
1-17-52	1½" to 1¼"	1¼"	1¼"	1¼" to 1½"

Note: (NPSH = National Pipe Straight Hose, sometimes referred to as PIP.

NPT = National Pipe Taper, referred to as IP.)

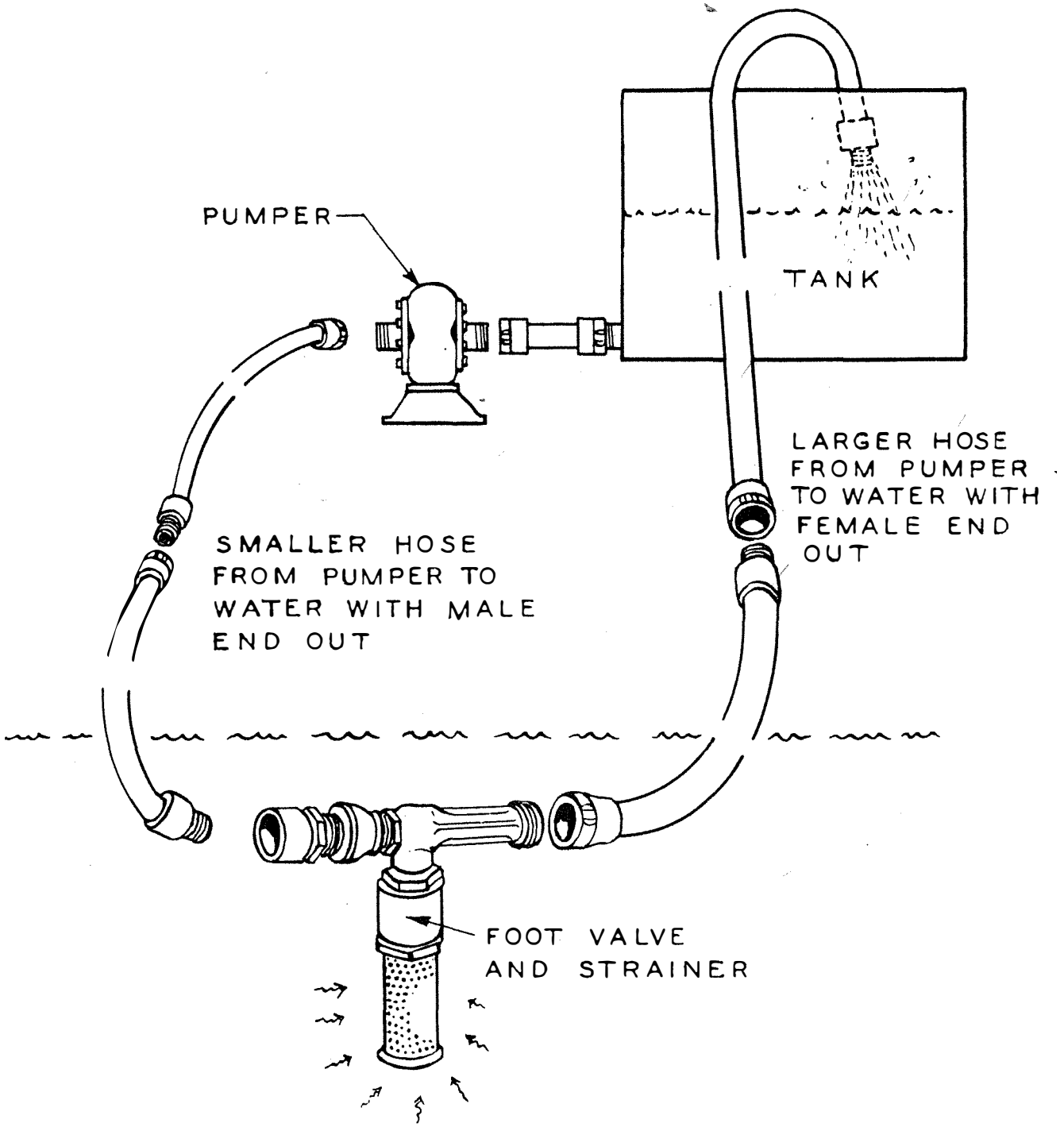
The amount of reserve water needed will vary with the hose sizes used, and the distance from the pumper to the water source. The minimum amount for each hundred feet of hose between pumper and source, is given in the table below:

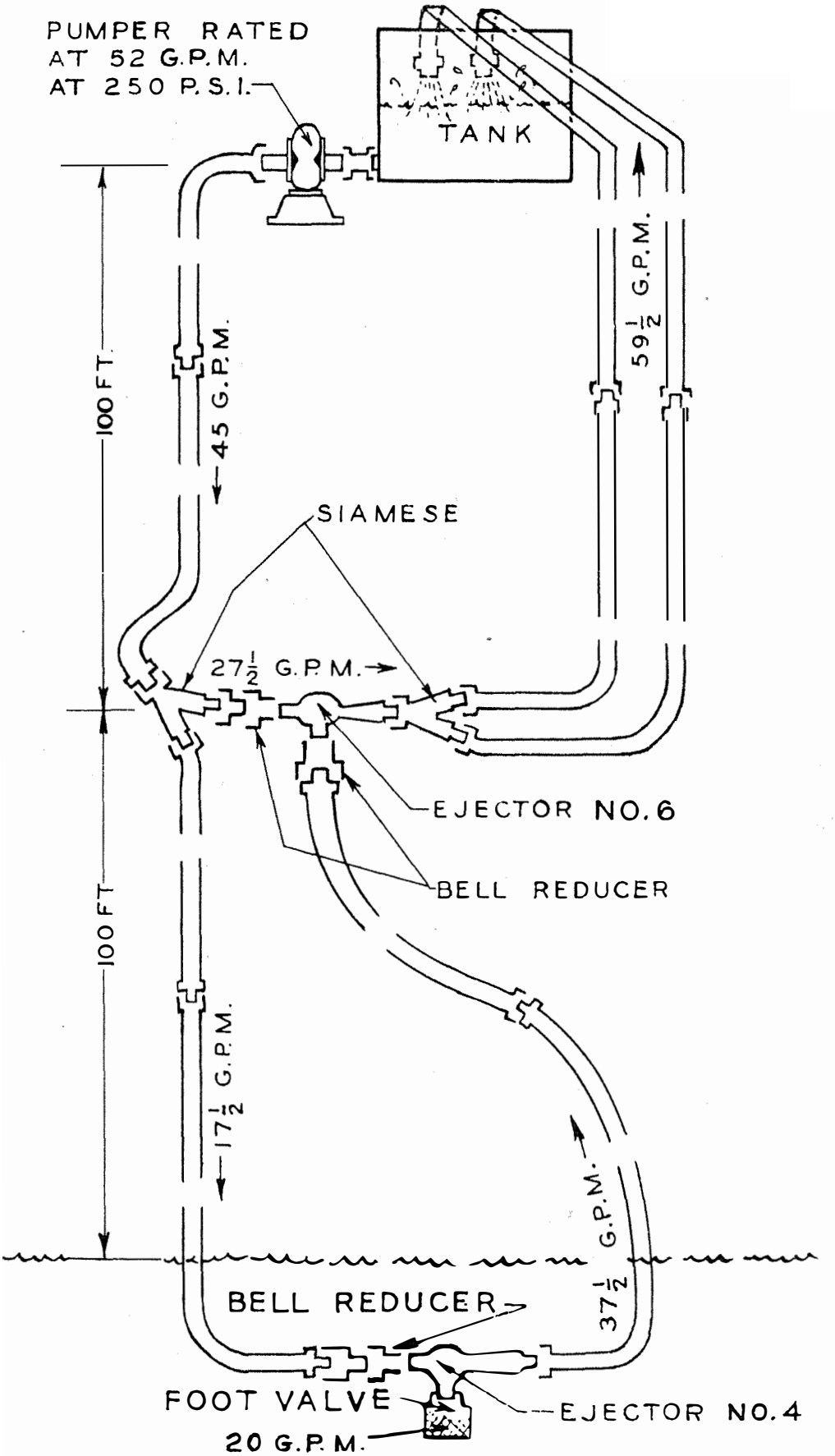
EJECTOR Number	Pressure Inlet Maximum Flow GPM	Pressure Inlet Hose Size	Discharge Maximum Flow GPM	Discharge Hose Size	Reserve Water per 100 Ft.
1	9.3	3/4"	16	1"	10
2	10.5	3/4"	27.5	1½"	10
3	11.5	3/4"	22.5	1½"	10
4	17.5	3/4"	38.0	1½"	15
5	16.5	3/4"	47.5	1½"	15
6	27.5	1"	59.0	2"	25
7	32.5	1"	87.0	2"	25

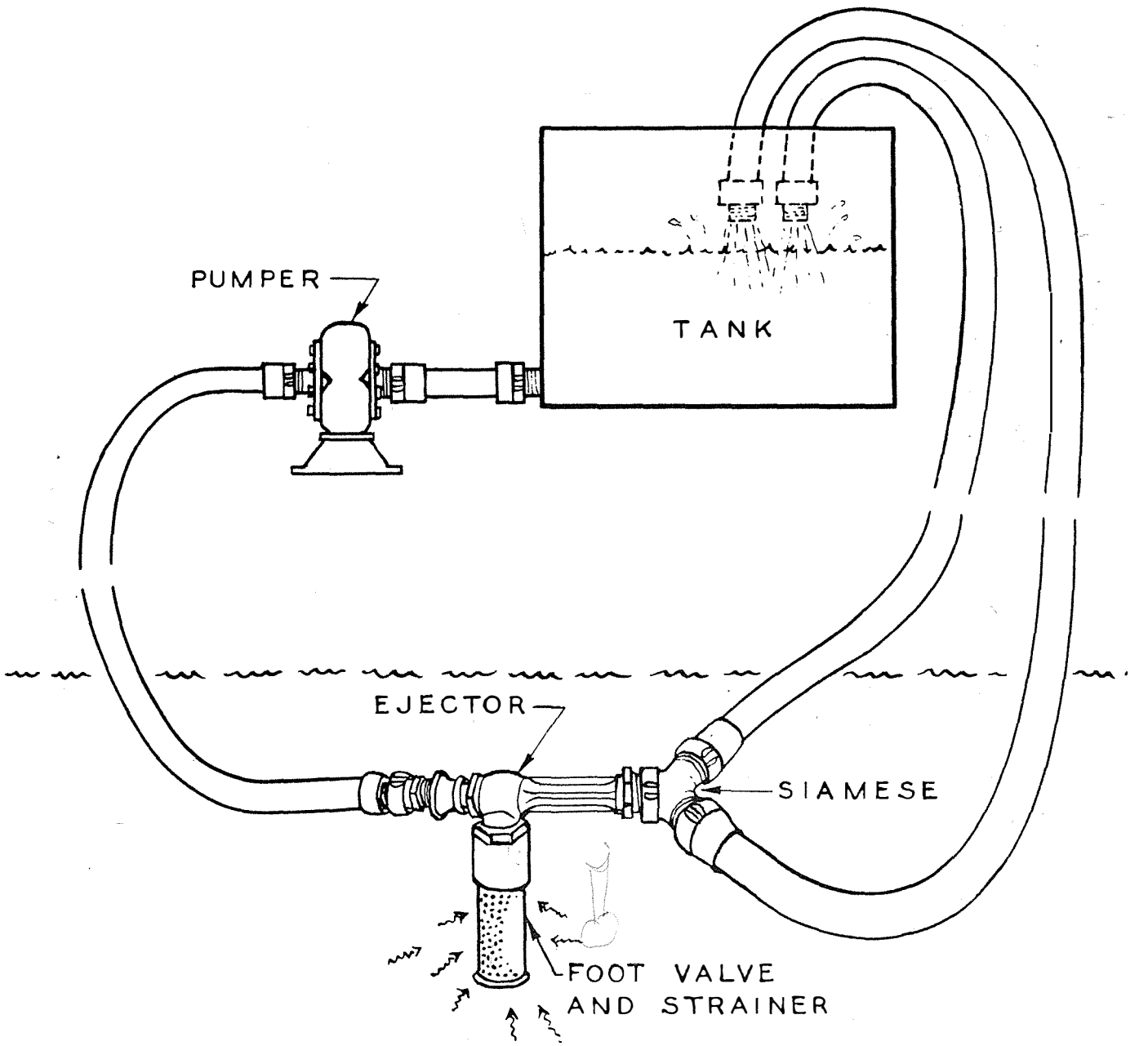
It should be explained that the smallest size of hose, which will carry the volume of water efficiently, is listed. The reason for this is that less reserve water is necessary to fill the smaller hose. Of course larger hose can be used, but more reserve water will be required.

As a matter of information, 11 feet of 1½ inch hose holds 1 gallon of water, whereas it takes 25 feet of 1 inch hose to hold 1 gallon.

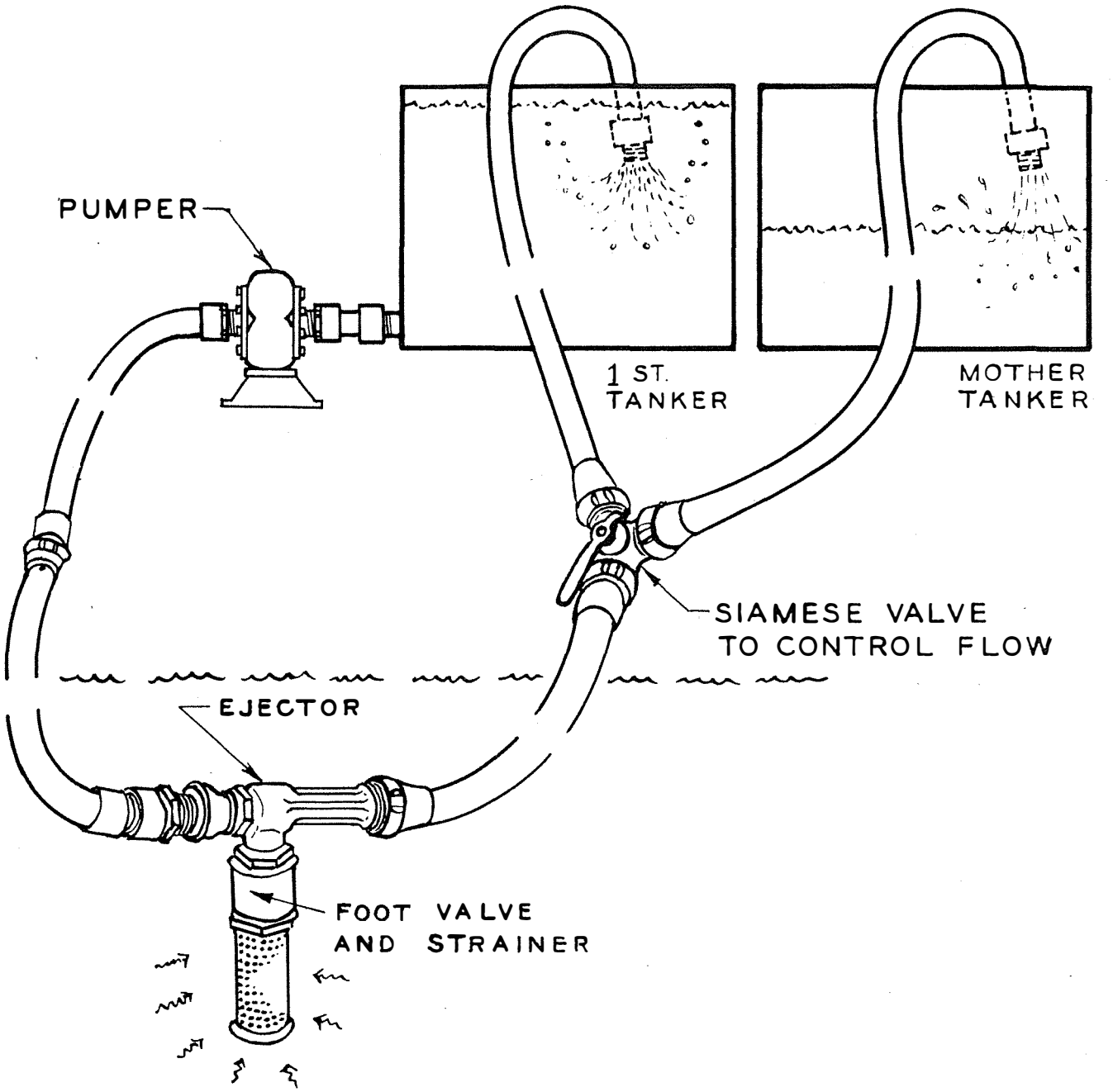
LAY HOSE FROM TANK TRUCK TO WATER SOURCE


PUMPER
TANK
LARGER HOSE FROM PUMPER TO WATER WITH FEMALE END OUT
SMALLER HOSE FROM PUMPER TO WATER WITH MALE END OUT
FOOT VALVE AND STRAINER


PUMPER RATED
AT 52 G.P.M.
AT 250 P.S.I.
TANK
100 FT.
45 G.P.M.
59½ G.P.M.
SIAMESE
27½ G.P.M.
EJECTOR NO. 6
BELL REDUCER
100 FT.
17½ G.P.M.
37½ G.P.M.
BELL REDUCER
FOOT VALVE
20 G.P.M.
EJECTOR NO. 4


PUMPER
TANK
EJECTOR
SIAMESE
FOOT VALVE
AND STRAINER

HOOKUP FOR FILLING MOTHER TANKER



THEORETICAL DISCHARGE OF NOZZLES IN U. S. GALLONS PER MINUTE

Head		Veloc'y of Disch. Feet per Sec.	Diameter of Nozzle in Inches				
Lbs.	Feet		1/16	1/8	3/16	1/4	3/8
10	23.1	38.6	0.37	1.48	3.32	5.91	13.3
15	34.6	47.25	0.45	1.81	4.06	7.24	16.3
20	46.2	54.55	0.52	2.09	4.69	8.35	18.8
25	57.7	61.0	0.58	2.34	5.25	9.34	21.0
30	69.3	66.85	0.64	2.56	5.75	10.2	23.0
35	80.8	72.2	0.69	2.77	6.21	11.1	24.8
40	92.4	77.2	0.74	2.96	6.64	11.8	26.6
45	103.9	81.8	0.78	3.13	7.03	12.5	28.2
50	115.5	86.25	0.83	3.30	7.41	13.2	29.7
55	127.0	90.4	0.87	3.46	7.77	13.8	31.1
60	138.6	94.5	0.90	3.62	8.12	14.5	32.5
65	150.1	98.3	0.94	3.77	8.45	15.1	33.8
70	161.7	102.1	0.98	3.91	8.78	15.7	35.2
75	173.2	105.7	1.01	4.05	9.08	16.2	36.4
80	184.8	109.1	1.05	4.18	9.39	16.7	37.6
85	196.3	112.5	1.08	4.31	9.67	17.3	38.8
90	207.9	115.8	1.11	4.43	9.95	17.7	39.9
95	219.4	119.0	1.14	4.56	10.2	18.2	41.0
100	230.9	122.0	1.17	4.67	10.5	18.7	42.1
105	242.4	125.0	1.20	4.79	10.8	19.2	43.1
110	254.0	128.0	1.23	4.90	11.0	19.6	44.1
115	265.5	130.9	1.25	5.01	11.2	20.0	45.1
120	277.1	133.7	1.28	5.12	11.5	20.5	46.0
125	288.6	136.4	1.31	5.22	11.7	20.9	47.0
130	300.2	139.1	1.33	5.33	12.0	21.3	48.0
135	311.7	141.8	1.36	5.43	12.2	21.7	48.9
140	323.3	144.3	1.38	5.53	12.4	22.1	49.8
145	334.8	146.9	1.41	5.62	12.6	22.5	50.6
150	346.4	149.5	1.43	5.72	12.9	22.9	51.5
175	404.1	161.4	1.55	6.18	13.9	24.7	55.6
200	461.9	172.6	1.65	6.61	14.8	26.4	59.5
250	577.4	193.0	1.85	7.39	16.6	29.6	66.5
300	692.8	211.2	2.02	8.08	18.2	32.4	72.8

SUCTION LIFT OF PUMPS WITH BAROMETRIC PRESSURE AT DIFFERENT ALTITUDES, AND EQUIVALENT HEAD OF WATER

Altitude	Barometric Pressure	Equivalent Head of Water	Practical Suction Lift of	
			Reciprocating Pumps	Centrifugal Pumps
Sea Level	14.70 lbs. per sq.in.	33.95 ft	22	15
1/4 mi. (1320 ft.) above sea level	14.02 " "	32.38 "	21	14
1/2 " (2640 ft.) "	13.33 " "	30.79 "	20	13
3/4 " (3960 ft.) "	12.66 " "	29.24 "	18	11
1 " (5280 ft.) "	12.02 " "	27.76 "	17	10
1-1/4 " (6600 ft.) "	11.42 " "	26.38 "	16	9
1-1/2 " (7920 ft.) "	10.88 " "	25.13 "	15	8
2 " (10560 ft.) "	9.88 " "	22.82 "	14	7

FIRE HOSE CONVERSION CHART

Size Inches	U.S. Navy Threads per inch	*U.S. Forest Service Threads per inch	Pacific Coast Threads per inch
1	11-1/2	11-1/2	11-1/2
1-1/2	11-1/2	11-1/2	11
2	11-1/2	11-1/2	10
2-1/2	7-1/2	8	7-1/2
3	6	8	---
3-1/2	6	8	---
4	6	8	---

*U.S. Forest Service is also known as National Standard hose thread or U.S. Straight (parallel) pipe thread.

SPECIFICATIONS AND CHARACTERISTICS

FOR

FIRE PUMPS USED BY THE U. S. FOREST SERVICE

PUMP:
BERKELEY: MODEL: 2EQ4
TYPE: 4 stage centrifugal
OUTPUT: 20 GPM at 400 PSI at 2500 RPM at sea level
TEST: 3/16" nozzle -- 360 PSI at 2500 RPM at sea level
ENGINE:
WISCONSIN: MODEL: VF4
4 cylinder aircooled
25 HP at 2500 RPM
NOTE:
WEIGHT: 1000#
Use ejectors Nos. 6 & 7 for general coverage.
Used on present Green Hornet.

PUMP:
BERKELEY: MODEL: 1½ TQ4
TYPE: 4 stage centrifugal
OUTPUT: 25 GPM at 200 PSI at 3000 RPM at sea level
Test: 3/16" nozzle -- 200 PSI at 3000 RPM at sea level
ENGINE:
WISCONSIN: MODEL: AENB
Single cylinder aircooled, with electric starter.
7½ HP at 3000 RPM
NOTE:
DIMENSIONS: L-32" - W-20" - H-23". WEIGHT: 240#
Use Ejectors Nos. 4 & 6 for general coverage.
Used to replace Edwards 120-A on 250 & 300 gallon slip-ons.

PUMP:
HALE: MODEL: HPZZ
TYPE: single stage centrifugal
OUTPUT: 15 GPM at 200 PSI at 3000 RPM at sea level
TEST: 3/16" nozzle -- 150 PSI at 3000 RPM at sea level
ENGINE:
BRIGGS & STRATTON MODEL: 23FB
Single cylinder aircooled, with electric starter.
8 HP at 3000 RPM
NOTE:
DIMENSIONS: L-24" - W-20" - H-20½". WEIGHT: 200#
Unit has exhaust primer.
Use ejectors Nos. 1 & 4 for general coverage.
Used on ½ to 1 ton slip-on tankers.

PUMP:
EDWARDS: MODEL: 120-A
TYPE: gear - positive type
OUTPUT: 30 GPM at 250 PSI at 2600 RPM at sea level
TEST: 3/16" nozzle -- 250 PSI at 2600 RPM at sea level
ENGINE:
ONAN: MODEL: CK
TYPE: 2 cylinder aircooled - electric starter - 12 volt
10 HP at 2600 RPM
NOTE:
DIMENSIONS: L-31" - W-19½" - H-20". WEIGHT: 130#
Use ejectors Nos. 4 & 6 for general coverage.
Used on 1½ Ton slip-on tankers.

PUMP:
PACIFIC MARINE: MODEL: GA-8-S
TYPE: gear - positive type
OUTPUT: 18 GPM at 250 PSI at 2800 RPM at sea level
TEST: 3/16" nozzle -- 250 PSI at 2800 RPM at sea level
ENGINE:
CLADDEN MODEL: 75
TYPE; Single cylinder aircooled, with electric starter.
7 HP at 3200 RPM
NOTE:
DIMENSIONS: L-29" - W-19" - H-24". WEIGHT: 130
Use ejectors 1 & 4 for general coverage.
Used on ½ to 1 Ton slip-on tankers.

PUMP:
PACIFIC MARINE: MODELS: FS & S6
TYPE: gear - positive type
OUTPUT: 18 GPM at 250 PSI at 2700 RPM at sea level
TEST: 3/16" nozzle -- 250 PSI at 2700 RPM
ENGINE:
SALSBURY: MODEL: 600
TYPE: Single cylinder aircooled, rope starter.
6 HP at 2700 RPM
NOTE;
DIMENSIONS: L-26" - W-15" - H-16". WEIGHT: 85#
Use ejectors Nos. 1 & 4 for general coverage.
Used on ½ to 1 Ton slip-on tankers.

PUMP:
PACIFIC MARINE: MODEL: NY PORTABLE
TYPE: gear - positive type
OUTPUT: 60 GPM at 100 PSI at 3500 RPM at sea level
TEST: 3/16" nozzle -- 250 PSI at 3500 RPM at sea level
ENGINE:
JOHNSON: MODEL: A
TYPE: 2 cycle 2 cylinder water cooled
9.8 HP at 4000 RPM
NOTE:
DIMENSIONS: L-24" - W-12" - H-15¼". WEIGHT: 70#

PUMP:
PACIFIC MARINE: MODEL: Y PORTABLE
TYPE: gear - positive type
OUTPUT: 20 GPM at 225 PSI at 4000 RPM at sea level
TEST: 3/16" nozzle -- 250 PSI at 4000 RPM at sea level
ENGINE:
JOHNSON: MODEL: A
TYPE: 2 cycle 2 cylinder water cooled
9.8 HP at 4000 RPM
NOTE:
DIMENSIONS: L-24" - W-12" - H-15¼"

PUMP:
OBERDOFFER: MODEL: 13
TYPE: gear - positive type
OUTPUT: 75 GPM -- 120 PSI
NOTE:

These pumps are driven by truck engine thru power-takeoff.
Now in use on ½ ton pickups on the Angeles Forest.

MAXIMUM VEHICLE LOAD - LIMITATION DATA FOR FIRE TRUCKS

TYPE UNIT	ALLOWABLE PAY LOAD	**ALLOWABLE TANKER LOAD		
1/2-T Pickup	1000 lbs.	*No. 1 Slip-On	W/50 gal.	Driver only
3/4-T Pickup	1500 lbs.	No. 1 Slip-On	W/60 gal.	Driver & 1 man
1-T Pickup	2000 lbs.	No. 1 Slip-On	W/110 gal.	Driver & 1 man
		No. 2 Slip-On	W/75 gal.	Driver & 2 men
Willys 4x4 Pickup	1500 lbs.	No. 1 Slip-On	W/60 gal.	Driver & 1 man
1-T Pow. Wagon	2500 lbs.	No. 1 Slip-On	W/160 gal.	Radio, Driver & 1 man
		No. 2 Slip-On	W/137 gal.	Radio, Driver & 2 men
1 1/2-T Stakeside	6000 lbs.	250 gal. Slip-On		Radio, Driver & 4 men
1 1/2-T M. H.S.S.	6500 lbs.	300 gal. Slip-On		Radio, Driver & 4 men

NOTE: These figures are based on 75% of maximum pay load for highway travel.

Weight of 1 man = 175 lbs.

* 200 lbs. overload, drive with caution.
** Approximately equal weights of water or equipment may be substituted for man or men.

1/2 to 1-Ton Slip-On Tank Weights

No. 1 - 3, Compartment		50-60-50 gal.			= 160 gals. Total
Wt. W/O water	- 509 lbs.	+	60 gals. (500 lbs.)	=	1,009 lbs.
" " "	-509 lbs.	+	110 gals. (916 lbs.)	=	1,416 lbs.
" " "	- 509 lbs.	+	160 gals. (1,333 lbs.)	=	1,842 lbs.
No. 2 - 3, Compartment	-	62-75-62 gal.			200 gals. Total
Wt. W/O water	- 529 lbs.	+	75 gals. (625 lbs.)	=	1,154 lbs.
" " "	-529 lbs.	+	137 gals. (1,140 lbs.)	=	1,669 lbs.
" " "	-529 lbs.	+	200 gals. (1,666 lbs.)	=	2,195 lbs.

1-1/2 Ton Slip-On Tanker

Size No. 1 = 250 gals. Size No. 2 = 300 gals.

Size	Tank Size	Unit Wt. Empty	Wt. of Water	Wt. of Tools & Equipment	Wt. 5 men	Total Weight
No. 1	250 gals. 22"x36"x72"	2,060	2,083	745	875	5,763
No. 2	300 gals. 26-3/4"x36"x72"	2,095	2,500	745	875	6,215

U. S. FOREST SERVICE

HOSE THREAD STANDARDS AND FITTINGS
(FOR FIRE TANKER EQUIPMENT)

The Forest Service has adopted the parallel iron pipe thread as our standard. This parallel iron pipe thread should not be confused with the standard pipe thread (tapered) as the external parallel pipe thread is larger in diameter, though a fit can be forced in an emergency.

HOW TO MEASURE AND IDENTIFY HOSE THREADS

Accurate identification can only be established from the "male" external thread as "female" (internal) threads may have varying amounts of "shake" or tolerance.

To identify a thread take the following steps:

A - Measure the inside diameter of the "male" fitting (the bore).

B - Measure the outside diameter of thread (maximum at dimension "B" on drawing). *(Drawing at top of page 65).

C - Using a thread pitch gauge, select the blade with teeth which accurately mesh with the threads and note the "threads per inch" indicated on the blade.

D - Refer to a fire hose thread - Reference Chart - and determine thread by comparison of data obtained with Reference Chart. (Drawing 2A-010 - page 65).

AUTOMATIC CHECK AND BLEEDER VALVE

This valve should be installed on portable fire pumpers when pumping against elevations of 200 feet or more. The check valve serves to hold pressure from heavy column of water when the pump is stopped, thereby facilitating restarting. The bleeder valve is opened before starting the pump and left open until the motor gains full speed. The outlet of the bleeder valve is threaded with 1" I.P. thread as emergency hose connection.
(Drawing 14x100 - page 49).

AUTOMATIC PRESSURE RELIEF VALVE

For use on all positive displacement pumpers to relieve pressure surge when the water is shut off by means of valves in line or accidental kinking of hose. The mechanism under spring tension bypasses the water and relieves excessive pressures automatically. The handwheel permits adjustment for 50-200 lbs.
(Drawing 14x105 - page 49).

BLEEDER VALVE FOR HOSE LINES

Installed at convenient points in the hose line to permit drawing off water for filling back-pumps and other use without interfering with pump or nozzle operation.
(Drawing 14x100 - page 49).

*All drawings can be found in Western Equipment Company's "Fire Handbook Catalog No. 41".

SIAMESE CONTROL VALVE

For 150 lbs. pressure serves to d one hose line into two and permit compl control of both lines to balance pressures or shut-off as desired. May also be used as a bleeder valve when starting pumpers against heavy back pressure in hose lines.
(Drawing 14x120 - page 49).

SIAMESE CONNECTIONS - DIVIDING TYPE

Used to divide one hose line into two where no control at point of installation is needed. Connections of the "reducing" type, i.e., 1-1/2" female to 2-1" male outlets, and the "straight" type i.e., 1-1/2" female to 2-1/2" male, are available.
(Drawing 4A-105 - page 81).

SIAMESE CONNECTION - UNITING TYPE

Used to join two hose lines into one to overcome excessive friction loss in long lines or insufficient pressure. Available in "reducing" type and "straight" type.
(Drawing 4A-117 - page 81).

NIPPLE, STANDARD, MALE BOTH ENDS

Designed for permanent attachment to pipe lines, hose valves hydrants, fire trucks and similar fixed installations. One end is always standard pipe thread (tapered). The other end is furnished with hose thread.
(Drawing 3A-005 - page 73).

NIPPLE, REDUCING, MALE BOTH ENDS

These fittings are used to connect hose to pipe of larger diameter. The large end is always standard pipe (tapered). The small end is a hose thread.
(Drawing 3A-035 - page 73).

NIPPLE, REDUCING, MALE BOTH ENDS

These fittings are used to connect hose to arge end is always standard pipe (tapered). The small end is a hose thread.
(Drawing 3A-035 - page 73).

NIPPLE, INCREASING, MALE BOTH ENDS

These fittings are used to connect hose to pipe of smaller diameter. The small end is always standard pipe (tapered). The large end is a hose thread.
(Drawing 3A-120 - page 73).

NIPPLE, STANDARD, FEMALE TO MALE

These fittings are used to connect a male pipe outlet to a hose fitting of the same size. Female end is always standard pipe thread (tapered). The male end is hose thread.
(Drawing 3A-205 - page 74).

NIPPLE, REDUCING, FEMALE TO MALE

These fittings are used to connect the hose to pipe of a larger diameter. The female end is always standard pipe thread (tapered). The male end is hose thread. (Drawing 3A-235 - page 74).

NIPPLE, INCREASING, FEMALE TO MALE

These fittings are used to connect hose to pipe of smaller diameter. The female end is always standard pipe thread (tapered). The male end is a hose thread. (Drawing 3A-321 - page 74).

HOSE CAP

A protective cap to prevent injury to exposed male hose threads. They should be provided to protect all exposed male threads to which the hose is not constantly attached.
(Drawing 3A-423 - page 75).

HOSE INLET CONNECTION

These fittings are used for filling tanks, etc. by hose line from other sources. One end is equipped with hexagon wrench grip and standard iron pipe thread (tapered). This end may be made up in either male or female. The opposite end is equipped with a standard female hose coupling swivel to permit attachment to male hose couplings.
(Drawing 3A-506 and 3A-606 - page 76).

HOSE THREAD ADAPTER

Used to connect couplings or hose fittings of equal diameter on which the threads differ.
(Drawing 3A-774 - page 77).

HOSE THREAD REDUCERS

Used to connect the outlet (male) end of any hose to the inlet (female) end of a smaller hose. The male threads on this reducer are always smaller than the female, as the reduction of diameter is in the same direction as the flow.
(Drawing 3A-812 - page 78).

HOSE THREAD INCREASER

Used to connect the outlet (male) end of any hose to the inlet (female) end of a larger hose. The male thread on the increaser is always larger than the female as the increase in diameter is in the same direction as the flow.
(Drawing 3A-941 - page 79).

DOUBLE MALE COUPLINGS

Used to connect hose lines when two female connections of the same diameter and same thread must be joined together.
(Drawing 4A-016 - page 79).

DOUBLE FEMALE COUPLING

Used to connect hose lines when two male connections of the same diameter and same thread must be joined together.
(Drawing 4A-033 - page 80).

SUCTION HOSE STRAINERS

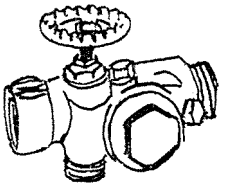
Suction hose strainers should be attached to the intake (male) end of the suction hose whenever drafting water from a questionable source. Failure to use these strainers has injured or completely ruined many fire pumps. In service, the strainer should never rest upon the sandy bottom of a stream or cistern. It may be placed in a gosh dern bucket and then submerged or suspended by means of a light rope.
(Drawing - Forestry type - page 82).

FOOT VALVE WITH STRAINER

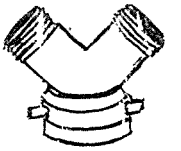
Installed on the intake (male) end of suction hose when drafting water 15 feet or more vertically, this foot valve will hold the pump primed if stopped.
(Drawing 5A-202 - page 92).

HORIZONTAL CHECK VALVE

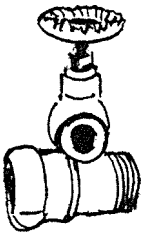
This valve may be placed on hose lines when pumping against uphill elevations. The check valve serves to hold the pressure of heavy columns of water when the pump is stopped, making restarting easier. They must be installed with the valve opening in the direction of flow and with the cap upwards.
(Drawing 5A-146 - page 92).



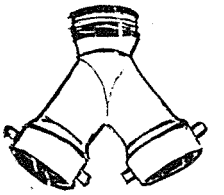
AUTOMATIC CHECK AND BLEEDER VALVE



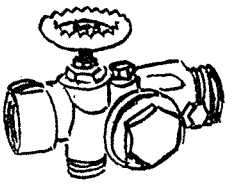
SIAMESE CONNECTIONS - DIVIDING TYPE



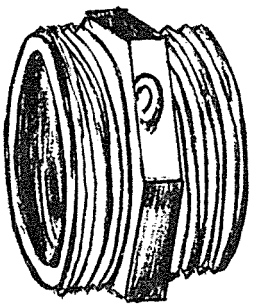
AUTOMATIC PRESSURE RELIEF VALVE



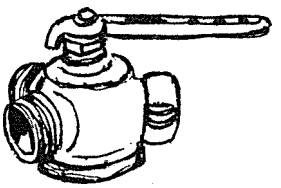
SIAMESE CONNECTION - UNITING TYPE



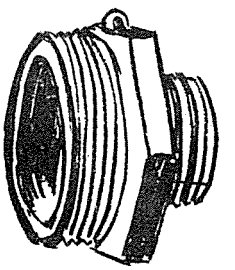
BLEEDER VALVE FOR HOSE LINES



NIPPLE, STANDARD, MALE BOTH ENDS

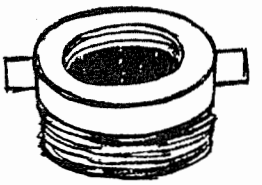


SIAMESE CONTROL VALVE



NIPPLE, REDUCING, MALE BOTH ENDS

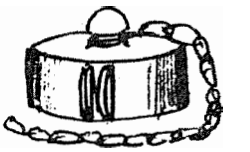
HOSE THREAD REDUCER



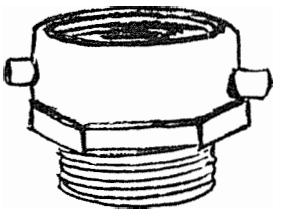
HOSE THREAD INCREASER

DOUBLE MALE COUPLING

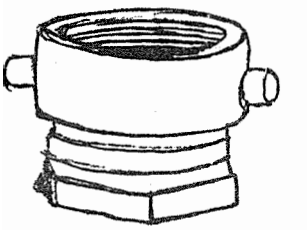
DOUBLE FEMALE COUPLING



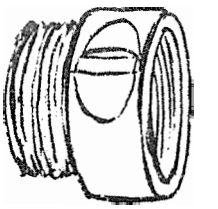
HOSE CAP



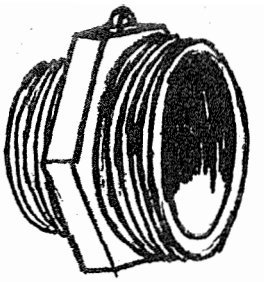
HOSE INLET CONNECTION
MALE TO FEMALE



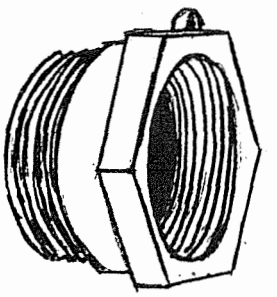
HOSE THREAD CONNECTION
FEMALE BOTH ENDS



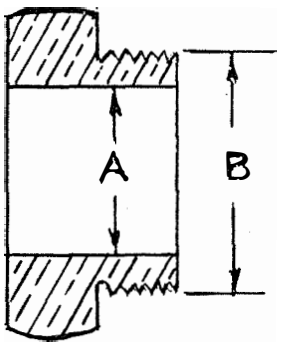
HOSE THREAD ADAPTER



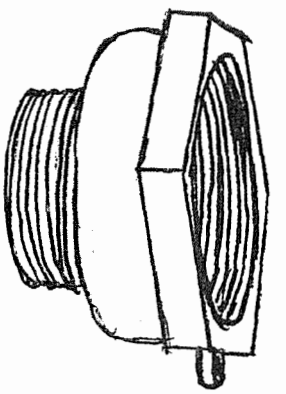
NIPPLE, INCREASING, MALE! BOTH ENDS



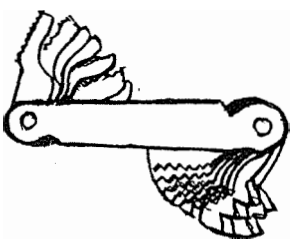
NIPPLE, STANDARD, FEMALE TO MALE



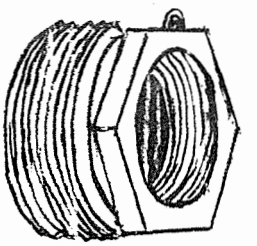
CROSS SECTION OF MALE THREAD



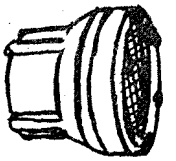
NIPPLE, REDUCING, FEMALE TO MALE



THREAD PITCH GAUGE



NIPPLE, INCREASING, FEMALE TO MALE



SUCTION HOSE STRAINER

FOOT VALVE WITH STRAINER

HORIZONTAL CHECK VALVE